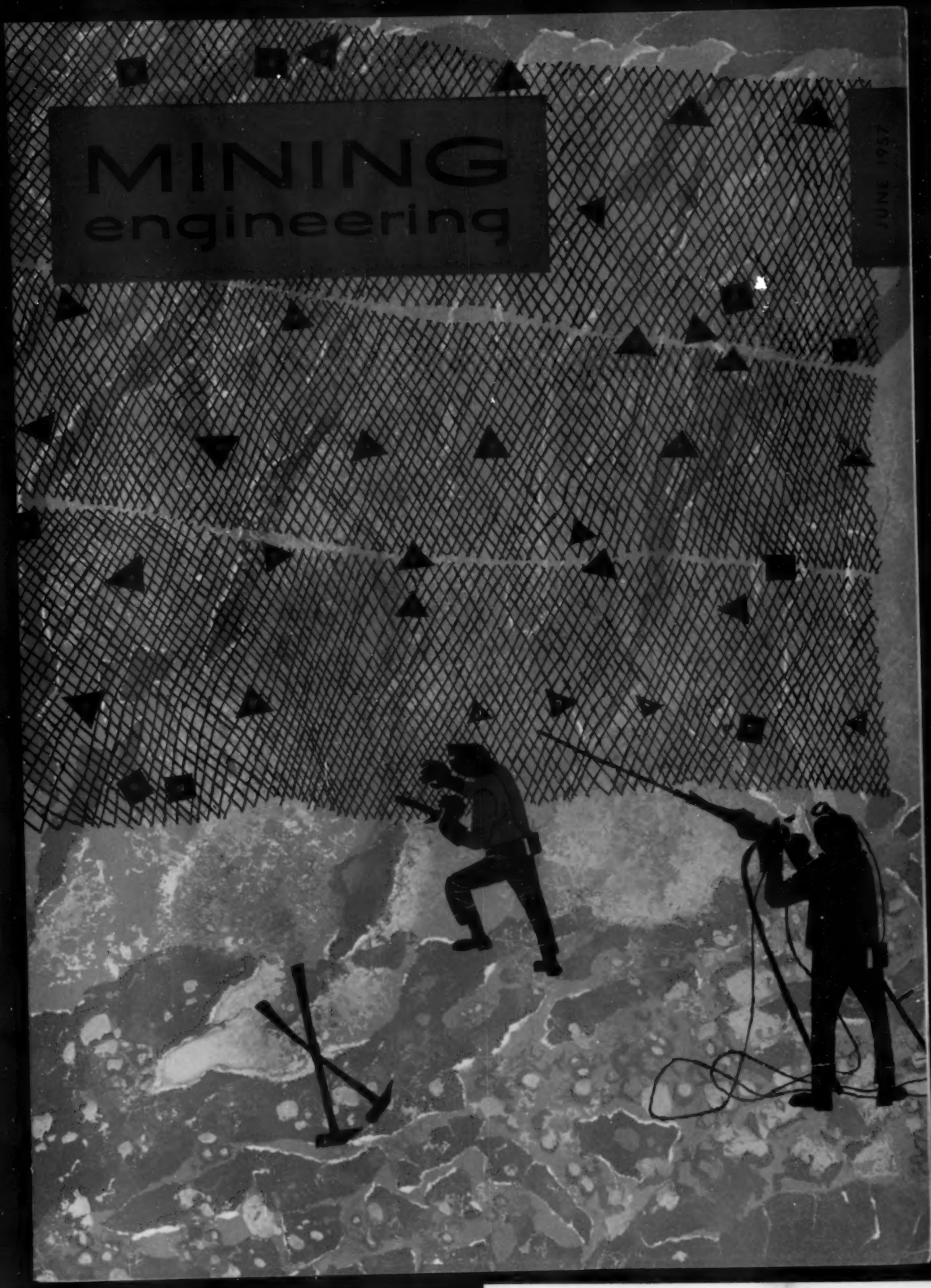
MINING engineering

JUNE 1957



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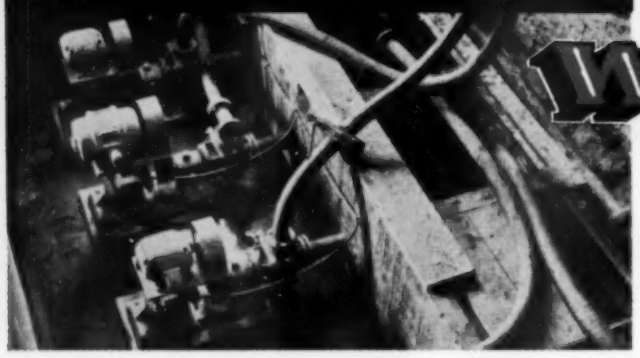

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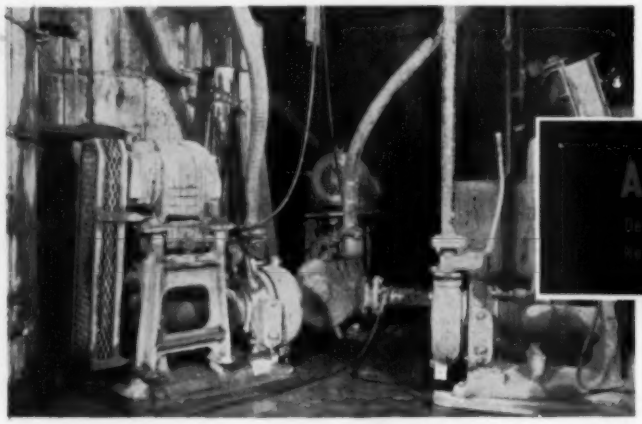

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ABC

MINING engineering

VOL. 9 NO. 6 JUNE 1957

COVER

Rock bolting systems, although initially expensive, are proving economical in long-term underground mining operations, and also are contributing an added safety factor not always achieved with older methods of shoring by timber props. Artist Herb McClure depicts miners at work installing rock bolts. Installation and use of a rock bolting system for roof control are described on page 646 of this issue.

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THE following employment items are made available to AIME members on a non-profit basis by the Engineering Societies Personnel Service, Inc. (Agency) operating in cooperation with the Four Founder Societies. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 100 Farnsworth Ave., **Detroit;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.** Applicants should address all mail to the proper key numbers in care of the New York office and include 6c in stamps for forwarding and returning application. The applicant agrees, if placed in a position by means of the Service, to pay the placement fee listed by the Service. AIME members may secure a weekly bulletin of positions available for $3.50 a quarter, $12 a year.

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(Continued on page 602)

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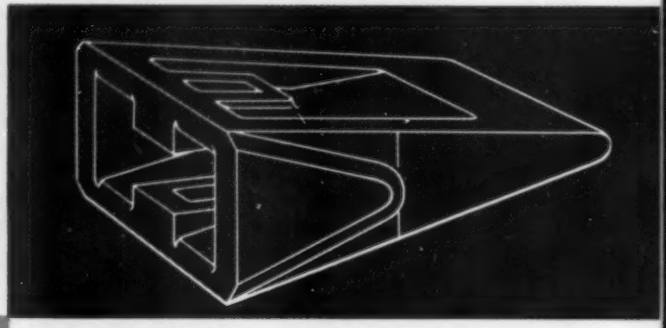
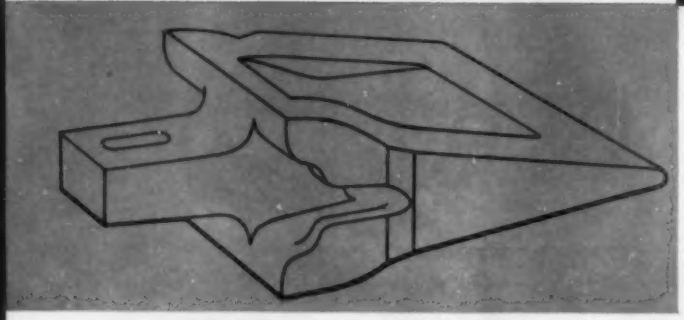
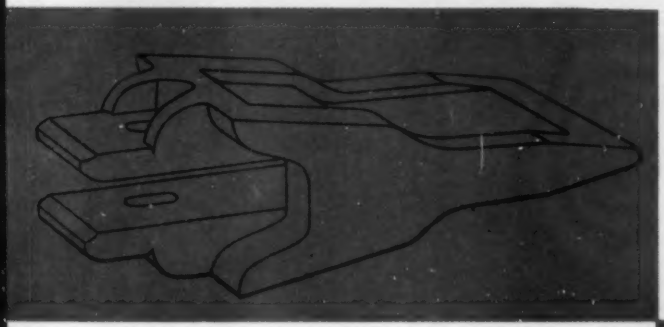




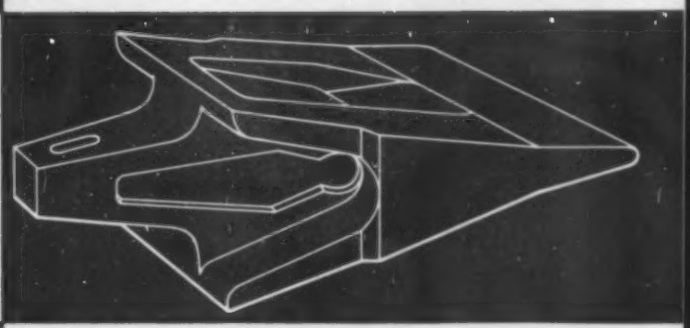
WEARPACT Style 1

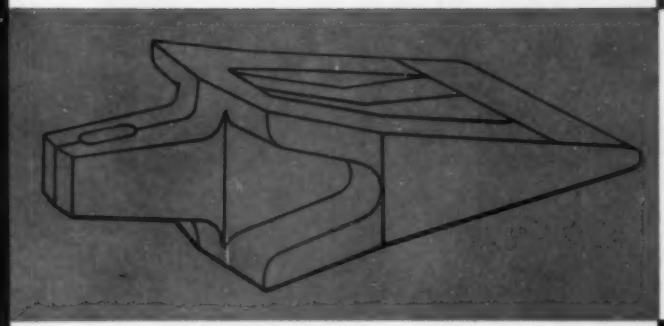
Typical Wearpact Steel teeth now used in leading mines



WEARPACT Style 5

WEARPACT Style 7





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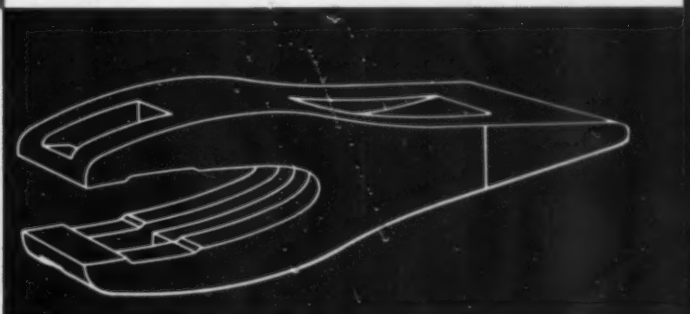
WEARPACT Combination Tooth and Base



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LETTERS

On page 1103 of the November 1956 issue of MINING ENGINEERING on the first page of the paper by Allen R. Rowen, *Lightweight Aggregate—Present and Future*, there is a statement in a box reading as follows:

"One of the greatest deterrents to more widespread use of manufactured lightweight aggregates is the fact that no industry-wide standards for its application exist. It is true that ASTM has specifications covering lightweight aggregate, but they are so broad as to be of little assistance in mix design work. Today even an engineer who has worked with one lightweight aggregate may be faced with re-education on his next lightweight concrete job if he is in an area served by another producer."

ASTM Activities

If you or Mr. Rowen, or anyone else, has a complaint or a suggestion for improvement regarding the *ASTM Specifications for Lightweight Aggregates (Designations C 331-53T, 332-54T, or 330-53T)*, I would appreciate it very much if it were communicated to me and to D. W. Lewis, National Slag Assn., 613 Perpetual Bldg., Washington 4, D. C., who is Chairman of Subcommittee III-f on Specifications for Lightweight Aggregate for Concrete of ASTM Committee C-9.

ACI Program

I hope that Mr. Rowen and others concerned with the use of lightweight aggregates in concrete mixtures are aware that Committee 613 of the American Concrete Institute, W. A. Cordon, chairman, has a subcommittee now actively working on the development of a "Recommended Practice for Selecting Proportions for Lightweight Aggregate Concrete," of which Joseph J. Shideler of the Portland Cement Assn., 33 W. Grand Ave., Chicago 10, is chairman. Suggestions concerning this subject would be welcomed by Mr. Shideler, by me, and by Mr. Rice, Technical Director, American Concrete Institute, 18263 W. McNichols Road, Detroit 19, Mich.

Attention is also invited to the existence and work of ACI Committee 213, "Properties of Lightweight Aggregates and Lightweight Aggregate Concrete", of which J. Neils Thompson, University of Texas, 173 Engineering Bldg., Austin 12, Texas, is chairman. The four papers making up a symposium on "Properties of Lightweight Aggregates and Lightweight Aggregate Concrete" presented at the 1955 ACI Convention have been published in the October and November 1956 issues of the *Journal of the American Concrete Institute*. They should help to reduce the deterrent mentioned in the quotation cited above. They are:

1. *Properties of Lightweight Aggregates and Lightweight Concretes*, by G. W. Washa.

2. *Structural Lightweight-Aggregate Concrete* by R. W. Kluge, which includes a section on proportioning and control of lightweight-aggregate mixtures.

3. *Lightweight Aggregates for Concrete Masonry Units*, by C. C. Carlson.

4. *Insulating Concretes*, by R. C. Valore, Jr.

BRYANT MATHER

Secretary, ASTM Committee C-9
Chairman, Technical Activities Committee, ACI.

(Ed. Note: We will welcome any further suggestions or discussion, for publication, on this subject.)

BOOKS

Coal Resources of the Lower Part of the Allegheny Formation in Ohio, by Richard M. DeLong, Report of Investigations No. 31, *Ohio Division of Geological Survey*, Columbus, Ohio, 43 pp., 50¢, 1957.—This study of the coal reserves in the lower part of the Allegheny formation in Ohio is devoted mainly to the Brookville No. 4 and Clarion No. 4A coal bed. The distribution and stratigraphy of minor beds—Ogan, Winters, Lawrence, and Scrubgrass is also shown.

The Metal Resources of New Mexico and Their Economic Features Through 1954, by Eugene C. Anderson, Bulletin 39, *State Bureau of Mines and Mineral Resources*, Socorro, N. M., 183 pp., $2.50, 1957.—This publication is a revision of Bulletin 7 released in 1932, plus an accumulation of information pertaining to the mining industry in New Mexico from 1932 through 1954, and statistics concerning metalliferous deposits. Included are maps showing known uranium occurrences and mining locations.

The Coal Industry of the USSR, a Report by the Technical Mission of the National Coal Board, Part 1, *National Coal Board*, Hobart House, Grosvenor Place, London S. W. 1, England, 107 pp., approx. $1.12, 1957.—In May and June 1956, a technical mission from the National Coal Board of England visited the Soviet Union to examine the mining techniques used in their coal industry. This is the first extensive survey of Soviet methods of production, engineering, underground mechanization, education and research, as observed at the Donbass, Kuzbass and Rostov coal-fields and at the various mining and research institutes. Photographs and diagrams supplement the text of the report.

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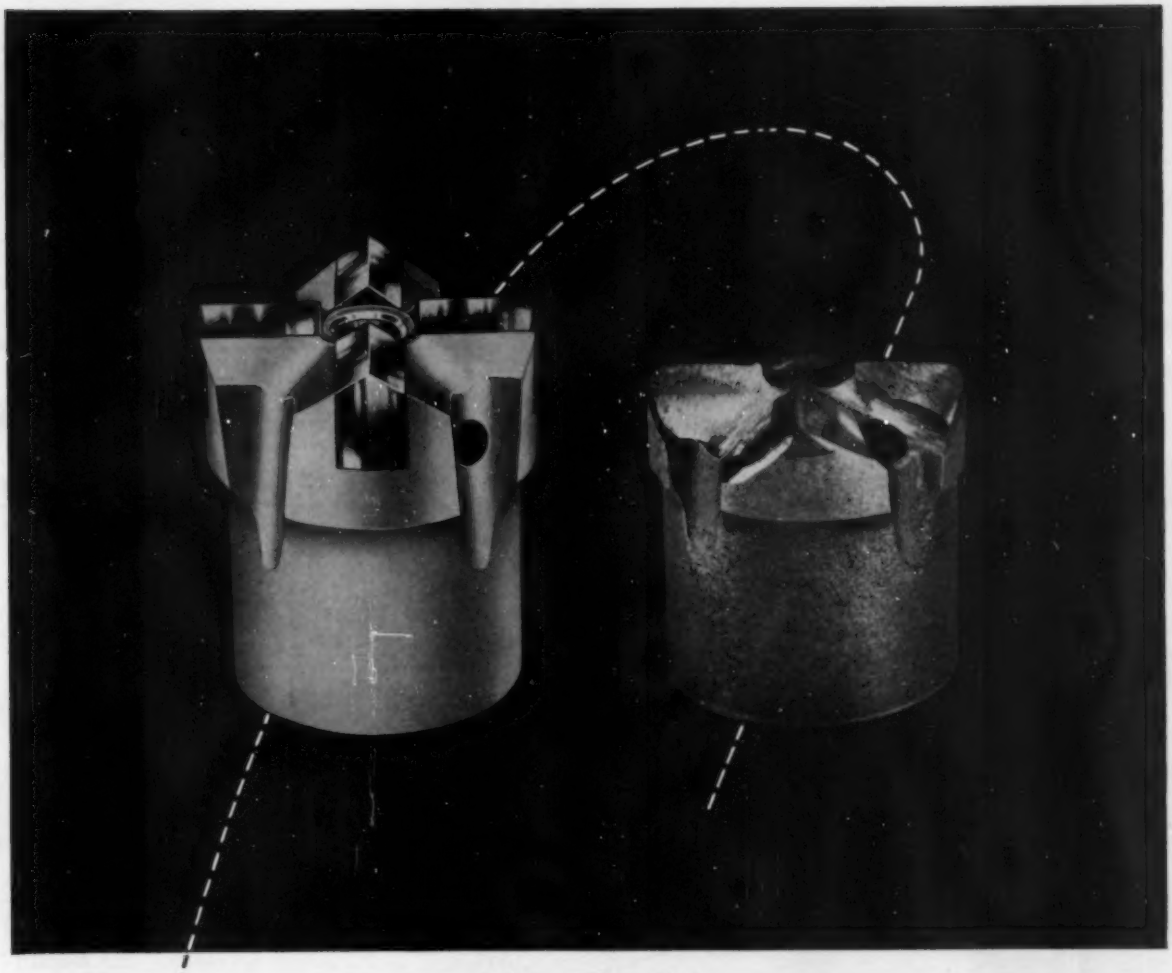

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1⅝"		1⅜"
1¾"		1½"
1⅞"		1⅝"
2"		
2⅛"	2½"	
2¼"	2¾"	
2⅜"	3"	
2½"	3¼"	
2¾"	3½"	
3"	4"	
3½"	4½"	
4"	5"	
4½"	5½"	
	6"	

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WRITE FOR FREE BULLETIN 172-7

Drilling Rock with a scleroscope hardness of 90-100 takes a lot out of most carbide bits . . . on this job, other bits were averaging 532 feet. Our illustration shows a Joy bit before and after drilling almost 800 feet in this formation. The average for Joy bits on the entire job was 781 feet.

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WSW C 6598-172

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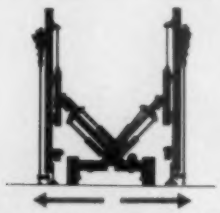

1. Hydraulic Boom Swing of 9'11" gives maximum usable hole pattern with a single crawler setup and permits line hole drilling along a face over the tracks.

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4. Hydraulic Feed-Tower Swing sets tower for vertical drilling on any slope—or positions drill for horizontal holes at any angle to crawler travel.

5. Hydraulic Feed-Tower Lift slides feed tower up or down, in or out—permitting foot pad to be set firmly on the ground.

HERE, in one unit, is a completely mechanized and self-propelled heavy-duty crawler drill that will greatly expand the scope of Wagon Drill operations. With *all* boom and feed-tower adjustments hydraulically controlled, you can make faster, safer and easier setups for drilling in *any position*. And because the CRAWL-IR can tow its own portable compressor, you save manpower and release auxiliary equipment generally required to move drills and compressors on the job.

The following advantages and features make this the fastest-acting, easiest drilling and safest unit of its type ever developed. It can be supplied with percussion or rotary drills, and with a wide range of optional hydraulic combinations when all of the power features are not required. Ask your I-R representative for complete information on this new self-propelled blast hole drill—or send for a copy of Bulletin No. 4189.

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S—513

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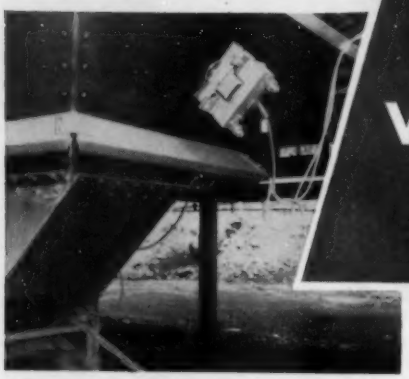
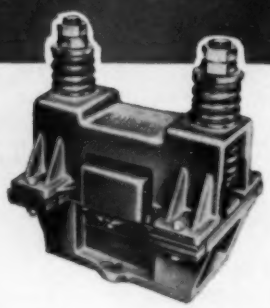
BIN

VIBRATORS





keep continuous mining equipment operating at full capacity all day

One of the most common problems encountered in the operation of continuous coal and ore processing equipment is the bridging and plugging of materials in storage bins, hoppers and chutes.

Syntron Electric Vibrators provide the most practical, the most economical method of combating this problem. Syntron Electric Vibrators with their 3600 controllable vibrations per minute keep even the most stubborn materials flowing freely to conveyor belts, screens, crushers and other continuous processing equipment.

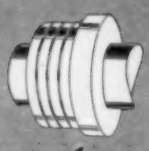
Easily installed. Available in a range of sizes to handle from 1 cubic foot hoppers up to big bins and bunkers. Send details of your problem—our application engineers will be glad to submit recommendations.

Builders of Quality Equipment for more than a Quarter-Century

Other SYNTRON Equipment of proven Dependable Quality

TEST SIEVE SHAKERS

SHAFT SEALS



GASOLINE HAMMER ROCK DRILLS

Write for complete catalog data — FREE

SYNTRON COMPANY

554 Lexington Ave. Homer City, Penna.

Personnel

(Continued from page 594)

ing, wash plants, research reports. Various phases open pit and underground mining on training program. Broad nonprofessional job experience. Prefer Midwest but will go anywhere. M-329-805-Chicago.

Chemical Engineer—Development, B.S. Met. Eng. 1952 and graduate work in Ch.E.; 27. Three and one half years experience as service engineer in pilot plant for titanium recovery; one year engineer-foreman large copper refinery. Presently research engineer nuclear materials. Prefer U. S. or foreign. M-330-774-San Francisco.

Geologist-Mining Engineer, M.A. Geol. '47; age 37. Brunton Award Student and Sigma Xi. Ten years as engineer and examination Rocky Mt. States for U. S. Bureau of Mines; three years exploration geologist and engineer for operating companies. Desire position western U. S. M-331-779-San Francisco.

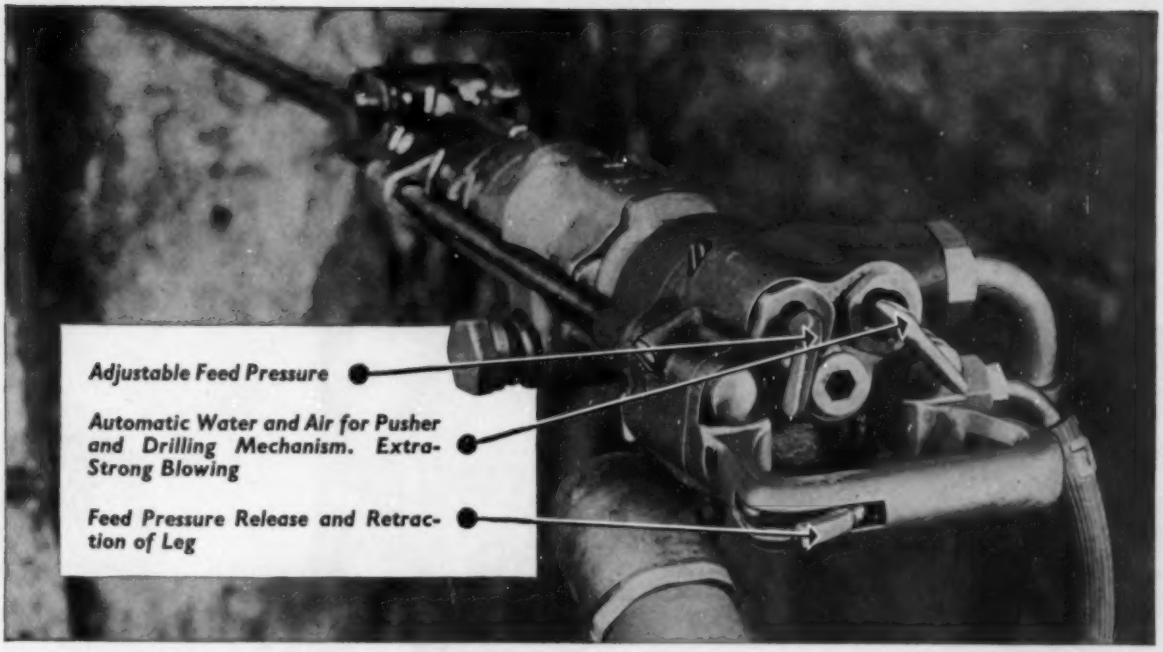
— POSITIONS OPEN —

Mining Engineer, young, with one or two years experience, for limestone mining company. Salary, $4500 to $6000 a year. Location, central Pennsylvania. W4945.

Assistant Professor, Ph.D. degree, with principal interest in the fields of mineralogy and petrology. In addition, may be required to teach some minor items such as possibly a section of physical geology and a section of field geology. Salary, open. Starts Sept. 1, 1957. Location, West. W4925.

Coal Mining Engineer, 40 to 65, degree in mining engineering, with minimum of ten years experience in coal mining industry, including exploration and development work, and supervisory work at production and management levels in underground coal mines. Must be familiar with all types of mining methods and equipment. Experience in thin seam mining preferred. Will act as consultant and advisor to foreign coal mining industry on all phases of exploration, development, and production. Salary commensurate with past earnings and experience; transportation expenses and quarters allowance will be paid. Location, foreign; climate subtropical; family may accompany applicant. Duration, 12 to 15 months with possibility of extension. F4858.

Geologists, field iron surveys, well qualified to take charge of field geological work on iron development; knowledge of, and capable of interpreting core logging data, magnetion survey report with or without supervision. 1000 to 5000 feet near large city. Salary, $8,400 to $12,000 a year plus expenses. Employer will pay placement fee. Location, Mexico; headquarters, San Francisco. S2825.


Adjustable Feed Pressure
Automatic Water and Air for Pusher and Drilling Mechanism. Extra-Strong Blowing
Feed Pressure Release and Retraction of Leg

THE ATLAS COPCO LION— A REVOLUTIONARY NEW ROCK DRILL

All controls under one hand

The Atlas Copco Lion is the first drill to have all the valves which operate the drill under the control of one hand. *Full and easy control without having to move the hand from the backhead!* All the controls have been designed so that they are well protected. While using them the operator's hand is never near the wall or roof of the drift. The Lion is the first pusher leg drill with controls placed for drifting.

Retractable leg saves time

When the leg has to be moved the feed pressure is easily released by squeezing the hand grip. By further pressure on the grip the leg retracts automatically. When the leg is in the new position suitable for continuous drilling, retraction stops and the feed pressure comes back by loosening the grip of the hand. *All this can be done while the drill is still running.*

This new idea of a retractable leg enables quicker repositioning of the leg and reduces the number of steel changes, thereby increasing footage per manshift. When drilling high holes it is now far easier to alter the position of the leg more frequently in order to maintain an optimal feed angle and feed pressure.

Packed with power for deep holes

The Lion has a drilling rate at least 30% higher than other rock drills of the same weight. Furthermore, it can maintain its high speed *even when drilling deep holes*. This means quickly drilled deep hole rounds and a faster advance. The Lion also reduces *to a minimum* the gauge wear of the bits in abrasive rock. And owing to the ease with which the feed pressure is released and brought back into action, the Lion is a *handier* drill to work with in fissured rock.

Sandvik Coromant—the steel for the Lion

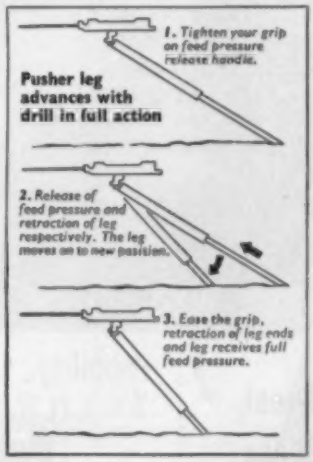
All Atlas Copco drills—and this goes for the Lion too—have been developed from the earliest stages with Sandvik Coromant tungsten-carbide-tipped integral steels and detachable bits. This combination pioneered tungsten carbide drilling in the early forties. No drill or steel developed separately could ever give such equivalently high performances as this drilling combination. Today it is the most widely used in the world, responsible for drilling more than 1,000 million feet annually.

For further information on the Atlas Copco Lion rock drill, and details of sales and service, please contact:

U.S.—Atlas Copco Pacific, Inc., 930 Brittan Avenue, San Carlos, California, or Atlas Copco Eastern Inc., P.O. Box 2568, Paterson 25, N.J.

CANADA—Atlas Copco Canada Limited, Montreal Airport, P.Q.

MEXICO—Atlas Copco Mexicana S.A., Apartado Postal 56, Torreon, Coahuila.

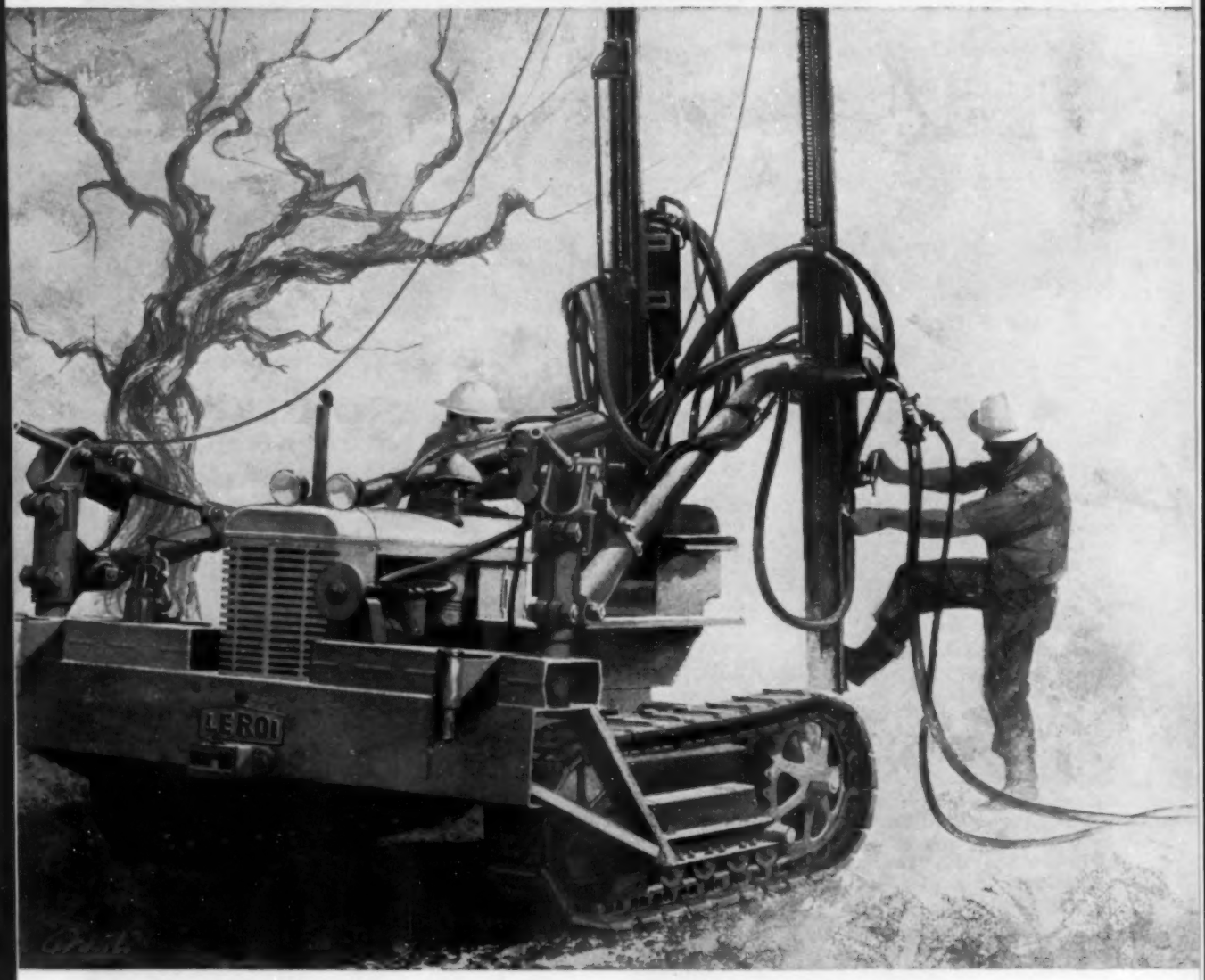

Pusher leg advances with drill in full action
1. Tighten your grip on feed pressure release handle.
2. Release of feed pressure and retraction of leg respectively. The leg moves on to new position.
3. Ease the grip, retraction of leg ends and leg receives full feed pressure.

Atlas Copco

D3574A

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment

LeRoi Dual Drill Rigs



Check these comparative features!

mobility:

1.

The T-286 can quickly speed across job-sites without compressor power.

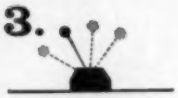
The air-driven track-type wagon drill can't move without an air compressor — must be loaded and unloaded by a crane.

2.

The T-286 unit can travel 7 mph — and pull the compressor, too!

The air-driven unit can only travel 3 mph.

3.

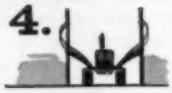


The T-286 has three forward speeds for better control, faster movement.

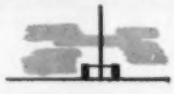
The air-driven unit has but one forward speed.

cost:

4.



The T-286 costs 20% more than an air-driven track-type wagon drill, BUT you get two drills instead of one—twice the production!



5.

The T-286 tractor unit alone costs slightly more than the track-type drill carrier, but it has extra usefulness—does other tractor work when not drilling.

T-286 unit features more power and speed for quicker positioning than track-type wagon drills.

Out-perform All Others!

Air motors do all the drill positioning, relieve most of the manual work

The Le Roi T-286 is a dual-drill rig mounted on a 28 hp crawler tractor. It gives you twice the production of competitive single-drill self-propelled units — yet costs only slightly more.

Its power and speed exceed that of other crawler wagon drills, giving faster movement across job-sites . . . quicker positioning . . . higher production.

Besides being a major time-saver, the tractor is useful after rock-work is completed; drills can be easily removed to permit use in cleanup work and other odd jobs. Yet the tractor itself costs only slightly more than a slow-speed air-driven self-propelled drill carrier!

Goes Anywhere

The T-286 is ideal for work-sites that are inaccessible to standard-type drill rigs. It can easily travel to places where manual positioning of wagon drills is slow and impractical — quickly reaches spots formerly drilled only with even slower and doubly back-breaking hand-held rock drills!

The crawler tractor takes rough ground easily. A parking brake and two leveling jacks stabilize the tractor while drilling on rough or uneven ground.

In operation, air motors position the drill arms through a wide arc, permitting easy, quick setups for any number of holes without relocating the machine. Each arm has a 7 ft. radius through 220 degrees . . . distance between drills is a maximum of 24 feet, allowing a variable drill pattern.

Drills High or Low Holes

Air motors change the positioning of the air feeds, too, through 360 degrees. This means easy placement of horizontal flat holes as high as 9 feet above ground level, as well as toe holes either backward or forward. Feed is positive whether the drill is being fed forward or retracting, giving faster drilling with both steel and tungsten carbide tipped bits.

The heavy-duty feed allows the use of either 3½ in. or 4 in. drifter with 10 ft. travel and 8 ft. steel change as standard equipment. Other size steel changes are available.

The dual drill rig may be bought separately for installation on *any* make tractor you now own. Write today for complete information on this useful high-production tool.

LE ROI DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF CLEVELAND AIR TOOLS, TRACTAIR ®, PORTABLE AND STATIONARY AIR COMPRESSORS, AND HEAVY-DUTY INDUSTRIAL ENGINES. WRITE US FOR INFORMATION ON ANY OF THESE PRODUCTS.

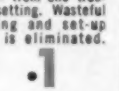
production:

6.

With its double drills, the T-286 can put down twice the footage of any air-driven wagon drill; handles holes up to 2¾ inch and depths to 24 ft.

7.

The T-286 can put in many holes—10, 20 or 30 — from one tractor setting. Wasteful moving and set-up time is eliminated.



The air-driven wagon drill puts down one hole per setting — must be repositioned for each hole.

utility:

8.

The T-286 has multiple uses—can do odd jobs, towing, cleanup work when drilling job is completed.

The air-driven wagon drill has only one use — is a dead investment when not drilling.

manpower:

9.

The T-286 needs two men— but both of them spend most of their time drilling — making hole — producing.

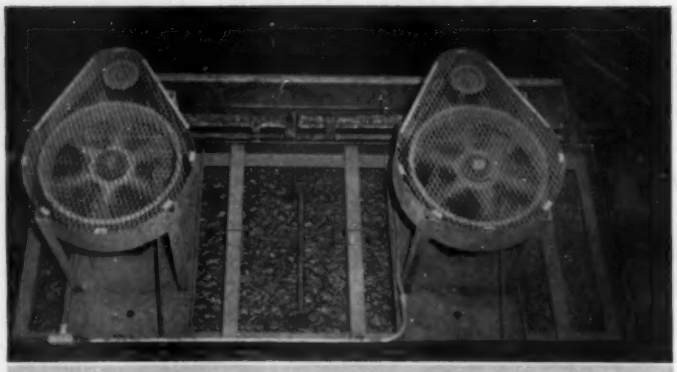
It also takes two men to operate the air-driven wagon drill, but only one is on the drill—the other must drive and position.

How about it?

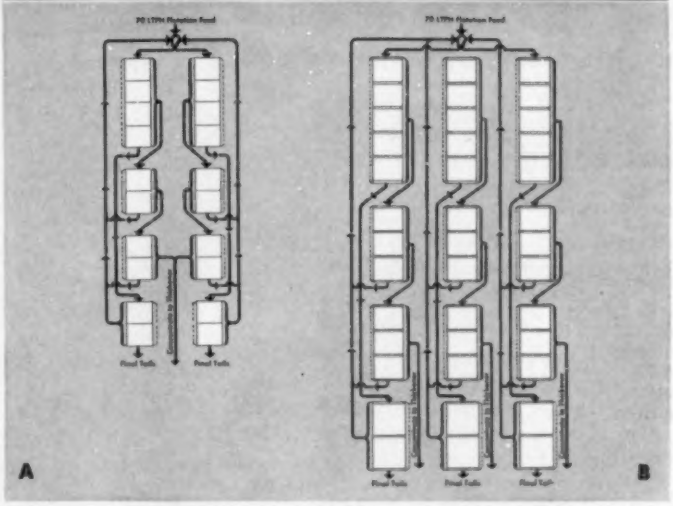
Can you afford to tie your money up in a low-production, one-use tool—when for slightly more you can get double production plus high quality?

WEMCO

Fagergren Flotation 8 ways better!



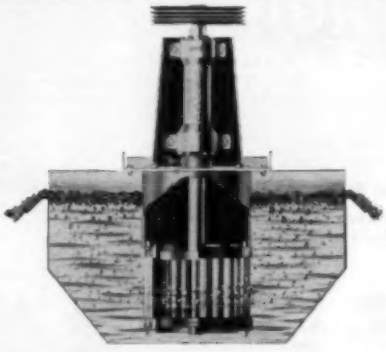
here's the proof: In an efficient new iron flotation concentrator, two parallel flotation circuits are used. Each receives identical feed, and each handles 70 long tons per hour with grade meeting market requirements. Check and compare these facts:



		Wemco Fagergren Units A	Other Flotation Units B
Circuit Characteristics	✓ Number of Cells	20	39
	✓ Gross Cell Volume[1]	1220 cu. ft.	2400 cu. ft.
	✓ Floor space (all cells)	644 sq. ft.	988 sq. ft.
	✓ Launder & Operating aisles (approx.)	167 sq. ft.	261 sq. ft.
	✓ Total Launder Length (approx.)[2]	225 ft.	375 ft.
Typical Metallurgical Results on This Type of Iron	✓ Units of Iron Recovered	1%-2% more	
	✓ Tailings Loss	1%-2% less	
	✓ Reagent Consumption	.2-.3 lbs. less per ton treated	

Notes: 1 – Taggart, Section 12 page 80, shows WEMCO-Fagergren efficiency of cell volume substantially greater than others, in addition to the above noted advantage in space alone.

2 – Shorter launder length in WEMCO circuit allows steeper slope; requires less wash water, causing less dilution of concentrate and minimizing dewatering requirements.



A reprint of the complete story is available for the asking. Write to:

WEMCO

WESTERN MACHINERY COMPANY
650 FIFTH STREET
SAN FRANCISCO 7, CALIFORNIA

Flocculant

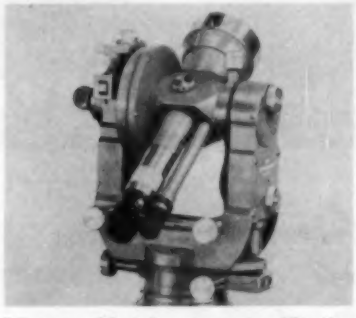
The Dow Chemical Co. flocculating agent, Separan 2610, has found much mill use in the filtration and separation of pregnant liquors containing uranium from solids and ore tailings. The high-molecular-weight acrylamide-type polymer has made countercurrent decantation feasible in certain industrial applications by decreasing production costs. In carbonate leach filtration, from 0.1 to 0.4 lb of the agent per ton of processed material has yielded four-fold filtration rates, while in acid leach filtration, from 0.05 to 0.2 lb of the flocculant per ton is claimed common. It has also been used in other mineral industries—copper, lead, zinc, manganese, soda ash, titanium. **Circle No. 1.**

Operations Recorder

A low-cost unit for recording frequency of mechanical operations is offered by *Gorrell & Gorrell.* An inkless stylus scribes data on a rotating drum that turns at speed required (from 4 min to 24 hr per revolution). Waterproof, easily filed 6x14-in. chart is capable of 400 linear in. of recording. Glass, transparent plastic, or metal housing may be had. **Circle No. 2.**

Theodolite

Wild Heerbrugg Instruments Inc. claims high accuracy and versatility for their Wild T-3 theodolite. Features include circle reading direct to



0.2 sec, with telescope magnification of 24x, 30x, and 40x. **Circle No. 3.**

Diesel Power

To meet the demand for an engine of high power output in a comparatively small, lightweight package, *Detroit Diesel Engine Div.* of General Motors has introduced a new 375-hp Turbopower unit. The 6-cyl diesel utilizes an exhaust-driven turbine and air impeller to supplement cylinder air supply. Result is better efficiency and power increases up to 25 pct. **Circle No. 4.**

Air Drill Hose

Hewitt-Robins Inc. has a heavy-duty hose for pneumatic drills that is claimed light, flexible, and easy to handle. Designated Duroil, the hose contains a Buna N tube covered with a braided rayon cord which is covered with natural rubber. It will be available in 500 ft reels, and diameters of ½, ¾, and 1 in. **Circle No. 5.**

Air Leg Diamond Drill

A diamond core drill that is cradle mounted on an air leg for short hole drilling underground is offered by *E. J. Longyear Co.* Powered by a 10 hp, 3000 rpm air motor, the one-man drill has rated capacity of 60 ft of E rod. The motor is equipped with

a hexagon slip chuck. A built-in water swivel-and-rod adapter has a hexagon spindle for easy coupling and uncoupling when adding steel. **Circle No. 6.**

Drawn Scrapers

International Harvester Co. says that loading efficiency of their two new scrapers is boosted by a three-segment adjustable blade. Segments are interchangeable and allow the operator to shift cutting depth to match soil conditions. The 4S-85 (shown) carries 16 cu yd struck and is matched for use with the 200-hp TD-24 crawler; the 4S-55, hauling 10

cu yd struck, is constructed to team with a crawler such as the 105-hp TD-18. Double ball bearing sheaves assure accurate sheave alignment. **Circle No. 7.**

Fast Belt Clamping

Quick-acting jacks instead of take-up screws speed the installation of conveyor belts with Far-Pul equipment by *Flexible Steel Lacing Co.*

As shown here, each end of the belt is clamped between bars and these are drawn together by a pair of ratchet jacks. When fasteners mesh, a pin is inserted, jack tension is released, and clamps are removed. Unit is easily operated by one man. **Circle No. 8.**

Big Crusher

Built for shovel feeding, the new Telsmith 42x48-in. jaw crusher is the largest of a ten-model line by *Smith Engineering Works.* Box section welded frame is two-piece and double walled. Large cylindrical roller bearings are used throughout. **Circle No. 9.**

Rock Bits

Six and 6½-in. Hole Master bits have been added to the line of percussion rock drill bits made by

Chicago Brunner & Lay Bit Corp. Splined body incorporates fast drilling carbide inserts. **Circle No. 10.**

News & Notes

A new expansion and rebuilding program by *American Cyanamid Co.* will increase its annual explosives production by about 60 pct—goal is set for September. . . . Construction of a crawler tractor plant at Hudson, Ohio, by *Euclid Div.* of General Motors will be finished by July 1958. . . . *Dorr-Oliver Inc.* has broken ground for a new worldwide headquarters in Stamford, Conn.

Open pit worker available

HAS FOUR-YARD SHOVEL . . . WILL TRAVEL

Will travel . . . there's the key to the real value of an Allis-Chalmers HD-21G tractor shovel. It not only digs and loads four yards at a pass, it is mobile enough to work in all parts of the pit . . . and flexible enough to do many different jobs well.

Besides loading hauling units, the HD-21G can strip over-burden, help maintain access roads, build stockpiles, feed and clean up around conveyors, or even clear land for future operations.

Let your Allis-Chalmers dealer show you the many ways an HD-21G can put its big, four-yard shovel to work profitably for you. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS *Engineering in Action*

Free Literature

(21) TRACTOR HANDBOOKS: *Eimco Corp.* has a pair of new handbooks that point to more efficient operation and maintenance of the Eimco 105 Tractor-Excavator and the 105 Front End Loader. Performance and safety are stressed in the 24-page brochure, B-L1055, covering operation of the excavator. The loader booklet (B-L1056) has four pages of data on this new attachment for the basic Eimco tractor.

(22) CONVEYOR PULLEYS: Welded steel conveyor pulleys for belt conveyor and bucket elevator systems are covered in Bulletin 5781 from *Chain Belt Co.* Features of the patented FD hub, and standard hubs are outlined, as well as three types of laggings. Drum type and self-cleaning wing type pulleys are included.

(23) OFF-HIGHWAY HAULERS: An 8-page illustrated folder describing the two models of the Payhauler off-highway truck is available from *International Harvester Co.* The 24-ton Model 95 and the 18-ton Model 65 are equipped with 14 hp per ton of load, assuring capacity for climbing steep grades, accelerating quickly, and reducing cycle time. On-the-job reports and photos cover mining, quarrying, and road operations in Booklet CR-592-G.

(24) SECONDARY-TERTIARY CRUSHERS: Greater flexibility in obtaining desired tonnage, product analysis, and product shape is designed into the Hydrocone secondary-tertiary crushers says *Allis-Chalmers Mfg. Co.* A Hydroset control feature permits rapid change in product size by raising and lowering the crushing cone hydraulically. In case of forced stoppage, Hydroset makes it possible to lower the cone and clear crushing chamber in minutes. Tramp iron is passed through by the hydraulic system and the crusher returns to its original setting. A new bulletin gives details and includes a table of average work indexes by types of materials.

(25) GALVANOMETER RECORDER: Specifications and features of the new *Texas Instruments Inc.* DUAL recti/riter, first two-channel rectilinear galvanometer recorder, are contained in 6-page Bulletin R-502. The instrument records two functions rectilinearly on two full 4½-in. scales on a single chart. It is available with a 10-speed fingertip-controlled transmission.

(26) BATTERY BUYING: Designed to help industrial battery buyers select the most economical and efficient battery for their operation is a

pocket-size reference booklet from *Gould-National Batteries Inc.* The 16-page guidebook describes the importance of proper selection, correct charging and handling, reasons for systematic maintenance, and need for continuing knowledge of battery condition. Three brief case histories demonstrate application engineering.

(27) APRON FEEDER: Folder BU427-571 from *Universal Engineering Corp.* gives feature highlights of the FD-8 apron feeder. Construction is of mass produced standard tractor parts so that one set of spare parts will serve both tractors and feeders. Pitch of the feeder chain is only 8 in. to provide even feed of material. Basic length of the FD-8 is 15 ft 10 in., but it is available in shorter or longer lengths in 1 ft increments.

(28) MOTOR GRADER: Working advantages of the Model Forty Five motor grader are covered in a new 16-page catalog available from *Allis-Chalmers Mfg. Co.* The 23,800-lb grader travels at a maximum speed of 20.6 mph employing a 120-hp diesel engine. Roll-Away moldboard is designed to give thorough mixing action on fewer passes and the blade can be adjusted to seven pitch positions.

(29) DRILLING EQUIPMENT: *Mobile Drilling Inc.* has a catalog packet that includes brochures on its mobile rotary drilling rigs and an extensive selection of earth drilling accessories including augers, core barrels, drilling bits, winches, couplings.

(30) TRANSFORMER MAINTENANCE: A new 50-page booklet entitled "Timely Tips on Transformer Maintenance" is offered by *Westinghouse Electric Corp.* Booklet B-4716-B includes data on general inspections, classifications, drying procedures, and connections.

(31) BLAST HOLE DRILL: Crawl-IR is a new self-propelled knee-action drill by *Ingersoll-Rand Co.* which is completely mechanized and hydraulically controlled. Boom swing allows a maximum hole spacing of almost 10 ft. Two propelling air motors are reversible and independently controlled for steering in any direction. Boom is 5½ ft long and feed tower is 15 ft high. The entire operation of positioning and drilling can be done by one man.

MAIL THIS CARD

for more information on items described in Manufacturers News and for bulletins and catalogs listed in the Free Literature section.

6

Mining Engineering **29 West 39th St.** **New York 18, N. Y.**

Not good after Sept. 15, 1957—if mailed in U. S. or Canada

Please send { More Information ☐ / Price Data ☐ / Free Literature ☐ } on items circled.

Name_____ Title_____

Company_____

Street_____

City and Zone_____ State_____

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11	12	13	14	15	16	17	18	19	20
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41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64						

Students should write direct to manufacturer.

(32) UNDERGROUND ANODE: "Zinc as a Galvanic Anode Underground," a 40-page illustrated book from the *American Zinc Institute Inc.*, discusses theory and practice of zinc anode application in transmission pipe lines, transmission line towers, ground rods, grounding cells. Specific recommendations point up the most effective methods of applying zinc for efficient protection of a variety of underground systems and structures made of steel. Tables, charts, and drawings are used.

(33) UNDERWATER ANODE: Another publication of the *American Zinc Institute Inc.*, "Zinc as a Galvanic Anode Underwater," gives 16 pages of data on corrosion protection of marine craft, water storage tanks, H piling in sea water, traveling water screens, and spillway and gate locks. Zinc claims the advantage of simple engineering and installation and of delivering adequate current without impractical size, numbers, or spacing of units.

(34) TRACTOR SHOVELS: Operating, performance, and maintenance advantages provided by *Allis-Chalmers* HD-16G and HD-21G tractor shovels are detailed in a new 8-page catalog available from the Construction Machinery Div. Bulletin MS-1102 also notes engineering, design, and construction features.

(35) BELT DRIVES: A completely new 112-page engineering data book for the selection and design of Poly-V belt drives is offered by Manhattan Rubber Div. of *Raybestos-Manhattan Inc.* Comprehensive data covers drive tables, horsepower ratings, installation instructions, trouble shooting.

(36) PORTABLE RADIOTELEPHONE: A new portable AM radiotelephone developed to handle field communications is the newest item in the *Kaar Engineering Corp.* line of communications equipment. Entirely self-contained in a watertight canvas backpack, the TR 246 Packset can be operated and carried at the same time. Special features include built-in metering facilities, receiver noise limiter, and squelch system. For portability and efficiency, the 16-ft antenna is the telescoping type.

(37) WHEELED TRACTOR: Model C Tournatractor adds mobility and speed to the usual tractor capability in power and traction says *LeTourneau-Westinghouse Co.* Use of all four "dimensions" is claimed necessary for the greatest investment returns. Form TD-265-356 stresses the Model C's lower maintenance, operating, and repair costs; instantaneous electric controls; built-in safety features; versatility through a complement of attachments.

(38) THERMAL DRYING: *McNally Pittsburg Mfg. Corp.* offers a new technical bulletin on thermal drying. Included in 20-page Bulletin 756 are complete descriptions with gas flow diagrams, dimension drawings, installation drawings of the McNally Vissac, Pulso, and Cascade dryers. All three coal dryers have completely automatic temperature and gas controls and are designed to eliminate or positively control dust and to eliminate degradation.

(39) PUMPING POWER: "Selecting Power for Pumping," a new 12-page handbook from *Caterpillar Tractor Co.*, contains a checklist of features necessary for continued dependable operation on pumping jobs. Caterpillar has a complete line of 13 heavy duty pump engines ranging to 650 hp.

(40) SMALL MAGNETIC SEPARATOR: Data on a compact, high intensity induced roll electromagnetic minerals separator, designed for laboratory and production control or development, is offered by *Carpco Mfg. Inc.* Bulletin lists 33 minerals which have been separated at feed rates of up to 2 lb per min. Designed to operate on 110-115 v dc, the unit is also adaptable to a-c use.

(41) CAT GRADERS: A brochure of on-the-job photos and data of *Caterpillar Tractor Co.* motor graders is newly released. Also listed in Form D704 is a set of attachments, among them a blade leveling device to assist in maintaining desired slope regardless of unevenness of the ground.

(42) WORM GEAR DRIVES: The standard line of speed reducers, worm gear sets, and special units by *Cleveland Worm & Gear Co.* is summarized in 16-page Bulletin 145.

(43) REFLECTOR SIGNS: *Mine Safety Appliances Co.* which has the mining and industrial distributorship for Scotchlite brand safety signs offers a catalog of standard and special legend types. The beam of a hand-light or miner's cap lamp is claimed to kindle the glass-beaded sign sheeting into reflective power up to 230 times greater than that of a white painted surface. Bulletin No. 0909-1 gives details and illustrations in color.

(44) STEEL BUILDINGS: A new manual on steel buildings by *Armco Drainage & Metal Products Inc.* details the Steelox panel method of construction. More than 5000 buildings are offered with the claimed advantages of simplified panel construction, neat appearance, little maintenance, and ease of expansion, rearrangement, or relocation.

(45) DRAGLINE BUCKET: Catalog A57 from *Page Engineering Co.* illustrates and details the new lightweight Page A Series automatic dragline bucket. Digging action automatically concentrates all of the bucket weight on the teeth.

(46) ROLLER CHAIN SPROCKETS: Roller chain shear pin sprockets prevent damage from jamming and other overloads and, by shearing, often signal impending trouble. Pins can be installed quickly and are made to shear at an exactly calculated value. Folder 2749 from *Link-Belt Co.* gives detailed information and tables listing stock sizes, torque ratings, hub dimensions, and keyseats.

(47) SEISMIC BLASTING CAP: The Vibrocap by *Hercules Powder Co.* was developed especially for seismic exploration work, to meet the requirement for an electric blasting cap that would register the time-break accurately in any shooting circuit throughout the entire range of low and high firing circuits. Booklet 63960 supplies complete information.

(48) TIN PLANT FLOWSHEET: *Denver Eqpt. Co.* offers a design study for a 200 tpd gravity and flotation tin plant. Flowsheet M7-F47 is based on test data on ore ranging 1.2 to 1.5 pct tin with arsenopyrite, pyrite, and pyrrhotite.

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In a wide variety of mining systems, where profit depends on high tonnage, low cost mucking... there are IMPORTANT REASONS why Eimco 630's get the job done better!

The 630 has a 6,000 lb. digging force behind its ½ cu. yd. bucket for fast digging. Overhead discharge eliminates time-killing turns and maneuvers. With experienced operator and good car availability, it is not unusual to expect production up to 4 tons per minute.

With his left hand the operator controls independent track movement... with his right, bucket motion. He can crowd the pile from any angle and manipulate the bucket simultaneously. He can twist, turn, get out of tight places at full speed under full load. Moveing the 630 from place to place is easy and fast.

Rugged construction and exclusive protective features insure against costly mechanical delays.

These among other factors make the Eimco 630 Excavator your best investment per cubic yard capacity. Write for full details or arrange to have an Eimco engineer visit you!

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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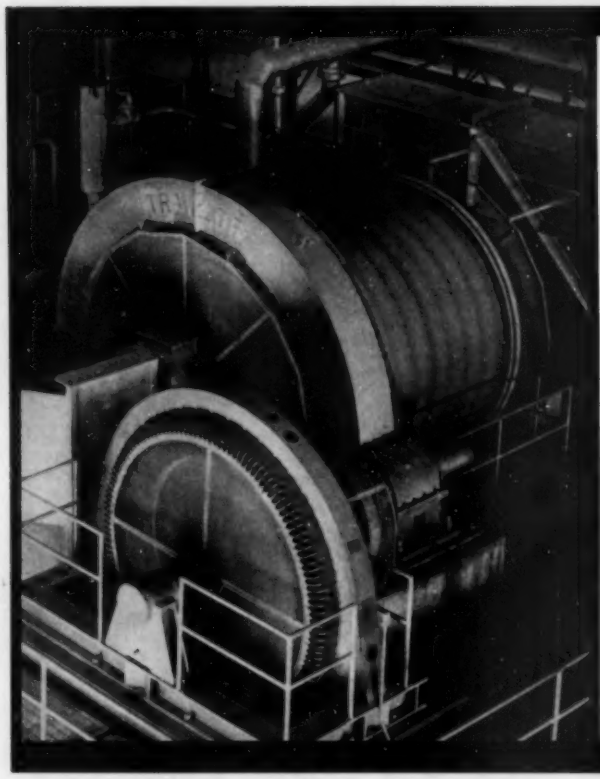
EIMCO

B-261

the expert fisherman
has his rod custom-made
because he gets
something **EXTRA**



the profit-wise operator

BUYS TRAYLOR BALL MILLS for the same reason

Leading producers rely on the proven features of Traylor-made Mills to achieve EXTRA production efficiency and lower operating costs.

Available in sizes to meet practically every requirement, Traylor Grinding Mills are offered in a wide variety of types including: Ball, Rod, Compartment and Tube Mills for wet or dry . . . coarse or fine grinding. Write for Bulletin No. 11-121

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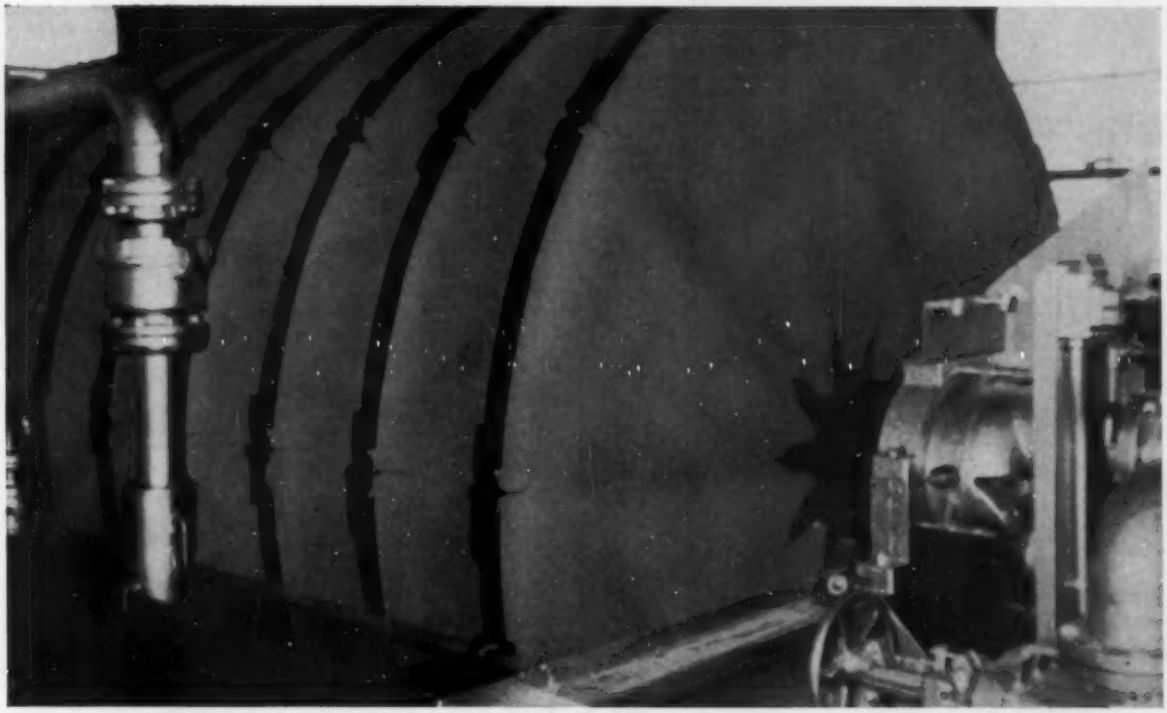
A Traylor leads to greater profits



NEW GILSONITE PROCESS EMPLOYS EIMCO AGIDISC FILTER

A transport system unique to the Gilsonite Industry was introduced recently when Gilsonite began flowing over mountainous terrain thru a 6" pipeline . . running 72 miles from **American Gilsonite's** Bonanza, Utah mine to a high process distillation plant at Gilsonite, Colo.

The mineral is crushed, suspended in water and pumped thru the line at a rate approximating 3 mph. Concentrate is fed into the station thru an 8' 10" x 10 disc **Eimco Agidisc Filter . .** the **only** filter employed in a separation process involving a Gilsonite slurry.

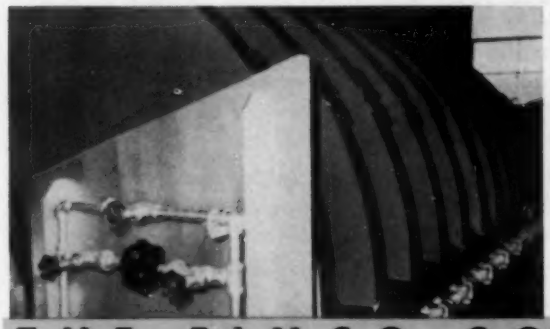
American Gilsonite, after years of research, decided this was a feasible transport method. It is anticipated that the line will deliver 260,000 tons of Gilsonite each year.

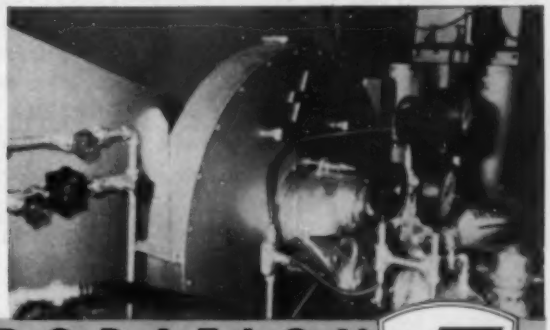
The **Eimco Agidisc** is regulative equipment for the plant, controlled entirely by automation. Methods employed will produce carbons extremely high in quality.

Teamwork between engineering personnel at **American Gilsonite** and **Eimco** resulted in the elaborate, highly practical piping system seen in the photos. **Eimco Hy-Flow Design** (lower right) is provided throughout the filter to permit "straight-through" flow of filtrate and air. Filtrate load is divided between two valves (one at each end of the center barrel) to further increase capacity.

These features, plus properly directed agitation and rugged steel construction, promote high velocity . . uniform particle suspension and cake formation . . low cake moisture content . . excellent filtrate clarity . . long, trouble free service.

Write today for full information on the Eimco Agidisc Filter.





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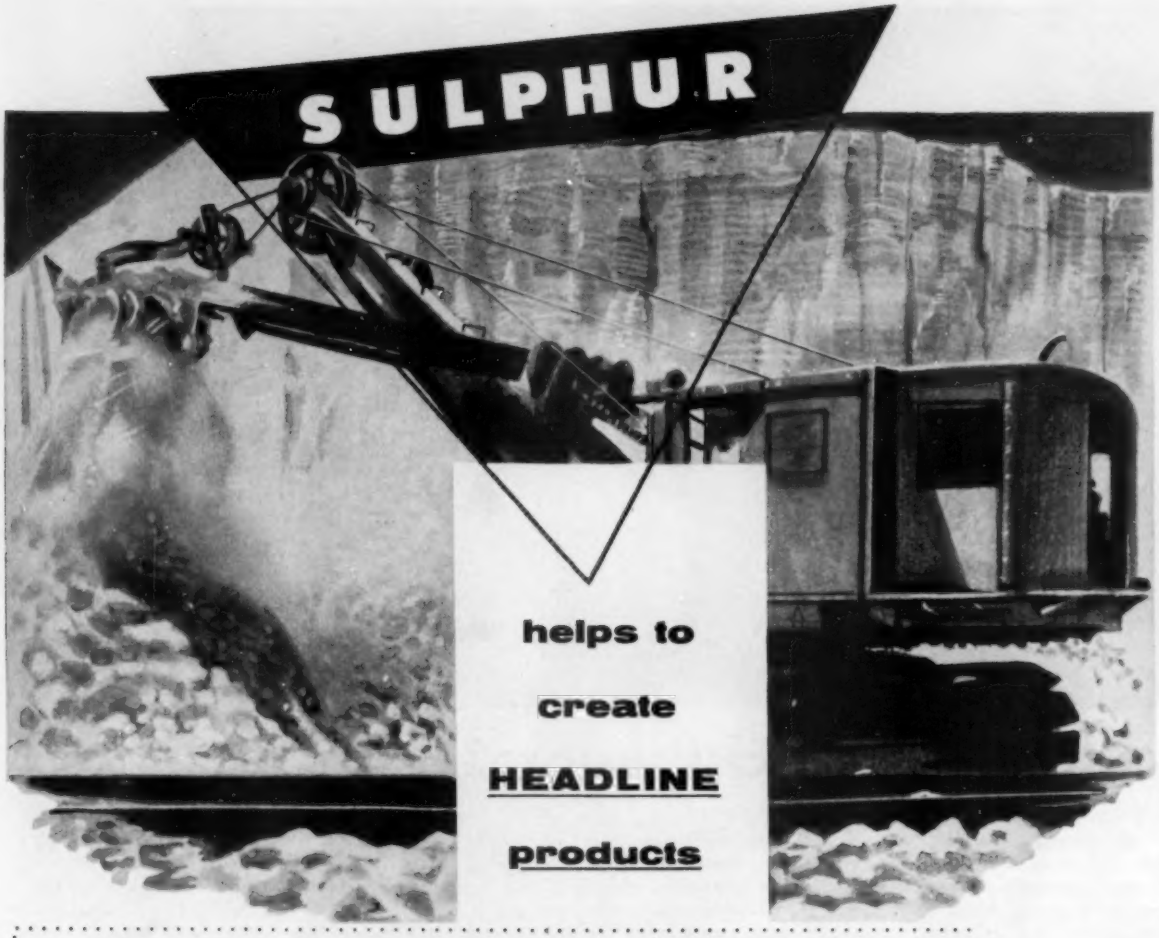
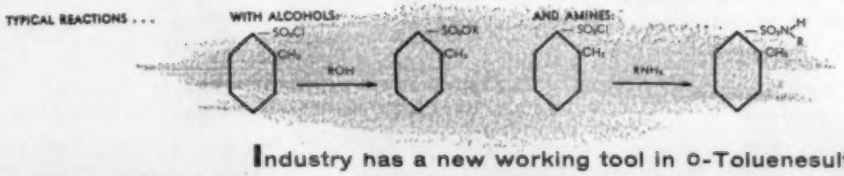


o-TOLUENESULFONYL CHLORIDE*



Industry has a new working tool in o-Toluenesulfonyl Chloride. This 98% pure ortho isomer can be used in building molecules for use in a wide variety of new products, from dyestuffs to pharmaceuticals; from plasticizers to herbicides. It is even possible that it is now being used in products you are making or have recently acquired.

From the chemical name of o-Toluenesulfonyl Chloride it is obvious that sulphur is a component of this compound . . . added evidence of the important role Sulphur plays in our industrial economy.

*Product of Monsanto Chemical Company

Texas Gulf Sulphur Co.

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- Worland, Wyoming

Quoting H.E. (ACE) GREEN, tunnel superintendent: "EIMCO 105 Excavators with heft to dig fast and overhead discharge, are the fastest tunnel loaders I've worked with."

The project was organized on a two cycle, 24 hour timetable with two drill and two mucking shifts. Here, Eimco 105 and dump wagons wait out blasting operations.

Quoting J. E. R. WOOD, president, NORTHWOOD INC.: "The fact that we have four EIMCO 105's is proof we're sure they promote high tonnage production."

WILKES-BARRE, PA. - Operator JOSEPH WEIKEL of Pottsville, Pa., prepares to unleash the EIMCO 105 Excavator's tremendous digging power during Bear Creek Diversion Tunnel operations. His comment: "It's the digginest machine I've operated."

The 19' circular bore was blasted through 1,150 feet of rock by NORTHWOOD INC. U.S. Army engineers directed the project.

EIMCO 105 SAVES TIME MUCKING FOR TUNNEL DRIVERS

"SAVES MINUTES EVERY CYCLE." That's how AL AITKEN, V-P, NORTHWOOD INC., supervisor of Bear Creek Tunnel operations, describes the EIMCO 105 Excavator's performance.

Part of the $18 million Bear Creek Reservoir Project, this tunnel will be outlet channel for the 234' high earthen dam. NORTHWOOD, with main offices in Vancouver B.C., is one of the Continent's active tunnel drivers.

Equipped with 1½ yard excavating bucket, the EIMCO 105 loaded 100 cubic yards of material into dump wagons after each blast. Between 200 and 400 lbs. of dynamite, used in a 48-hole drilling and shooting pattern (usually fired in 10 stages of delay) produced an average advance of 7½' per round . . . 15' per day.

The tunnel was drilled to a bore size of 19' in the rough using 6 jack legs on a single deck jumbo. Concrete lining will reduce inside diameter to 16'. Six inch I-beam supports wedged tightly with wooden blocking are spaced every 4'. The EIMCO 105 now is taking up a 4' bottom left to provide flat surface for trucks.

NORTHWOOD'S high appraisal of the EIMCO 105 is duplicated often in field reports from tunnel projects and mines throughout the world.

With any attachment--Excavator, Front-End Loader, Bulldozer, Fork Lift, and others--EIMCO 105 owners get superior design . . performance speed and power . . . operating ease and economy . . . versatile maneuverability . . . dependable service under hard usage.

Plan now to learn why you can shade your next bid and still keep the profit by figuring earthmoving costs around the EIMCO 105.

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Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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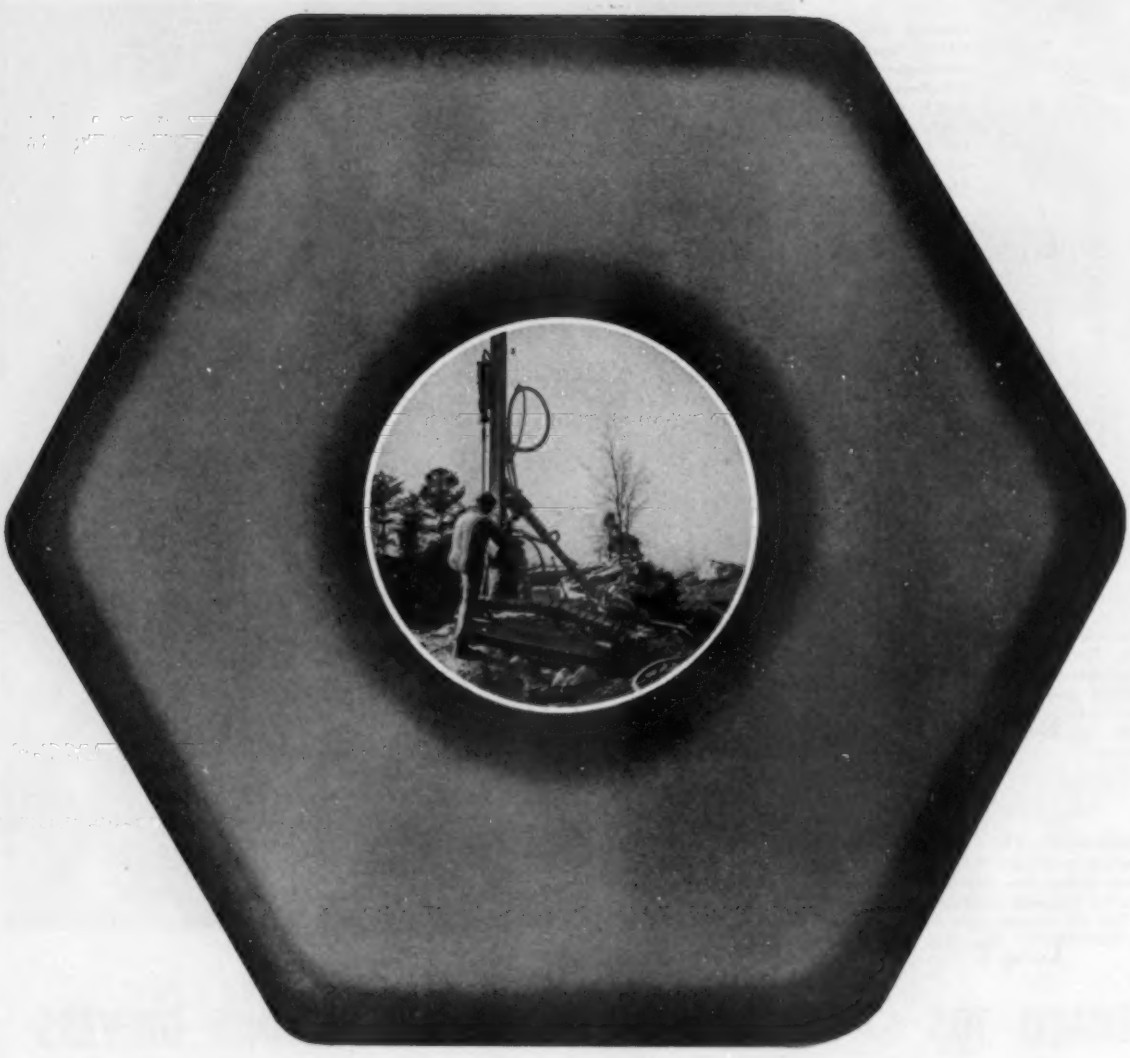


4320 Steel Solves the Problem of Carburized hollow drill rod

The Gardner Denver Co., Denver, Colo., felt that a carburized hollow drill rod would provide maximum resistance to wear combined with ability to stand up under impact and vibratory stress.

The problem was to find a steel that could be heat-treated in 20-foot lengths to develop these properties and which would maintain straightness within tolerance.

Gardner Denver found the answer in 4320 Ni-Cr-Mo Steel. As their chief metallurgist explained:

"The alloy content of 4320 assures uniform hardening of both case and core to the values necessary for long life, and minimizes distortion."

The enlarged picture above shows an etched cross-section of a carburized 1¼" percussion drill rod. Notice the uniformity of the hardened case on both outer and inner surfaces.

One of the special combinations of properties available from nickel alloy steels may be the answer for your service or fabrication needs. No trouble to find out. Send details of your problem and we'll be happy to make a suggestion.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

Eagle-Picher Shuts Down Tri-State Zinc Operations

The first major cutback in zinc production was effected with the late April closure by Eagle-Picher Co. of its mining and milling operations in the Tri-State District. Sixty pct of the company's total mining activity was thus halted. A company official laid the move to generally increasing metal stocks in the hands of producers and a continual whittling of inventories by consumers. No indication was given of when operations will resume.

Anaconda Reports Uranium Ore Reserves

Anaconda Co. states that its uranium deposits currently represent 15 million tons of ore averaging 0.16 pct U_3O_8. During 1956 long range development work was continued on the Jackpile mine in New Mexico, and a new "major" orebody was developed on the Laguna Reservation a few miles distant. Anaconda's Bluewater plant is presently treating 3000 tpd of uranium ore.

New Level Planned for Climax Mine

Climax Molybdenum Co. announces start of a program to develop a new level 300 ft below the Storke level at the Climax mine in Colorado. Eight years of development work are planned, by which time the Phillipson level will be depleted at present rate of production. Exploration work is also going on at the fringe of the Climax deposit to determine if more ore can be added to the present reserve of 300 million tons.

Long Distance Slurry Pipelines in Use

Tests have been resumed on the 108-mile coal slurry pipeline stretching from Cadiz to Eastlake, Ohio, after the clearing of a stoppage which is said to have been the result of an improper size mixture. Officials of the companies involved in the development expect other troubles will be encountered before regular operation begins, but express no discouragement. . . . Gilsonite is now being transferred successfully in slurry form through a 72-mile pipeline in Utah and Colorado. The pipe is 6-in. diam and carries 700 tpd.

Borax Open Pit Strikes Tincal

A new open pit mine operated by Pacific Coast Borax Co. at Boron, Calif., has reached the crude native borax, tincal, at a depth of 137 ft. The mine is the first large open pit borate operation in the U. S. Seven million tons of overburden have been removed since the pit was started early last year. Production is scheduled to begin this month.

Second Ambrosia Lake Uranium Milling Contract

A contract covering purchase of uranium concentrates to be produced by a newly planned mill in the Grants, N. M., area has been signed, with the AEC, by Homestake-Sapin Partners. The latter is a limited partnership by Homestake Mining Co. and Sabre-Pinon Corp. The projected 1500-tpd mill will cost about $9 million and is scheduled for completion in about 14 months.

NORDBERG MACHINERY
. . . used by leading TACONITE producers

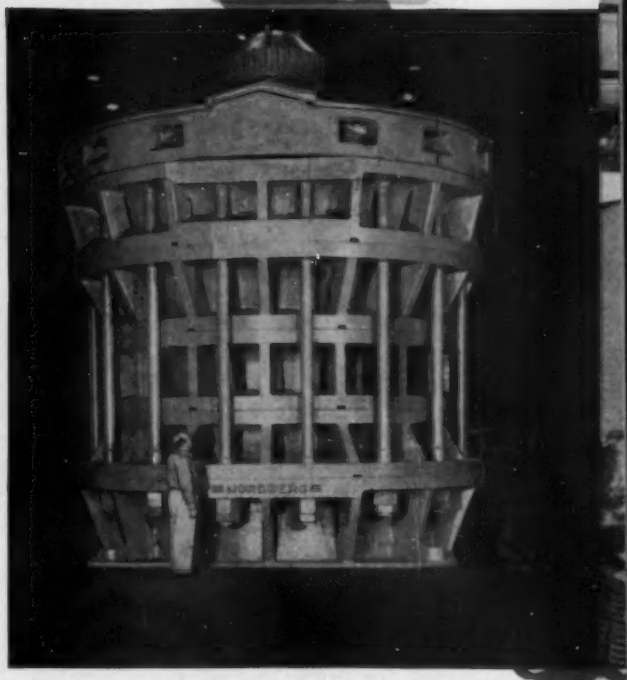
To provide adequate iron ore reserves for today's increased steel production, the large-scale beneficiation of Taconite ore has become imperative.

Long used in the economical production of Taconite concentrates in the Arctic region of Norway, Nordberg Machinery is now serving the huge Taconite operations in northern Minnesota . . . where a new era in U.S. iron ore production is now underway.

The selection of Nordberg Machinery for the processing of the extremely hard Taconite ore again follows the trend of the mining fraternity to rely on this heavy duty machinery for its proven ability to reduce ores and minerals at low per ton cost.

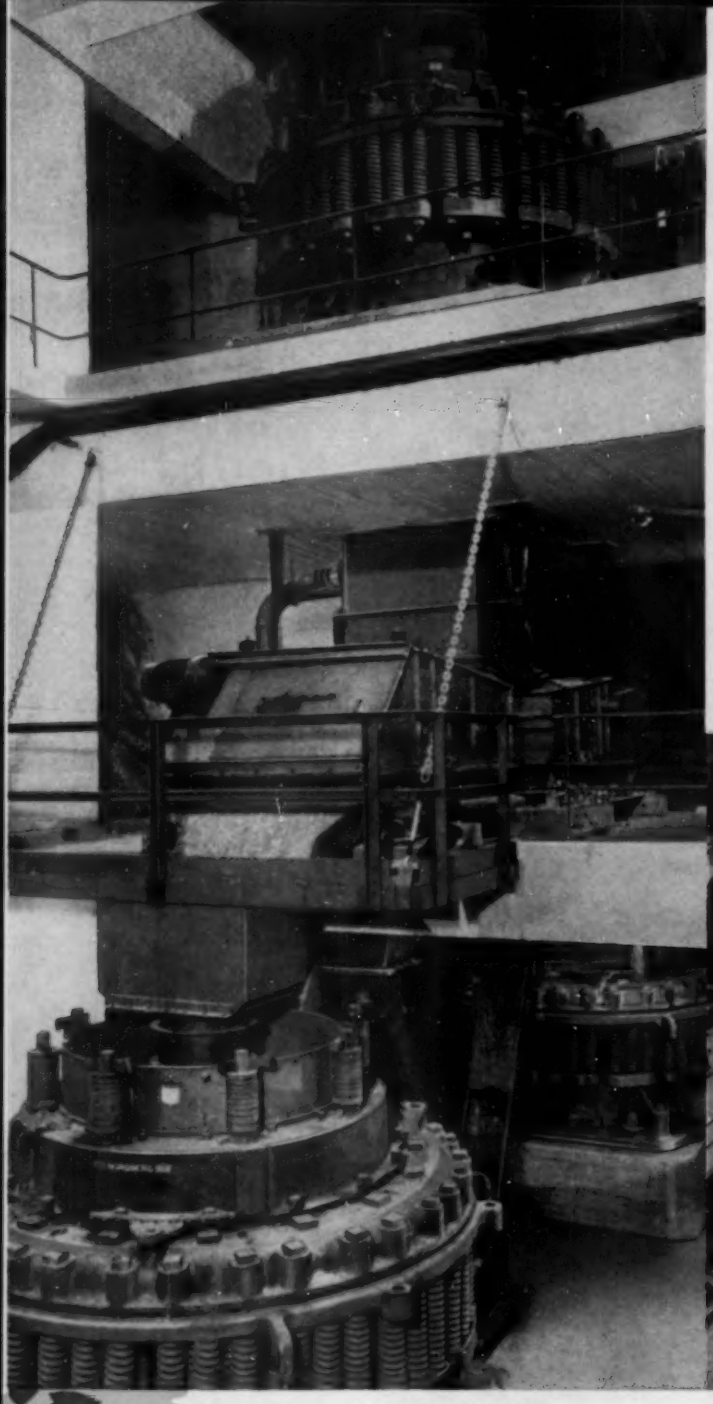
Nordberg Machinery now in use by leading Taconite producers includes Symons® Primary Gyratory Crushers, Symons Cone Crushers, Nordberg Rod and Ball Mills, and Symons Rod Deck Screens.

While *your* crushing and processing problems may not involve Taconite, you may be sure that Nordberg machinery is the logical choice for practically any other ore and mineral processing operation where big tonnages at low cost are required.

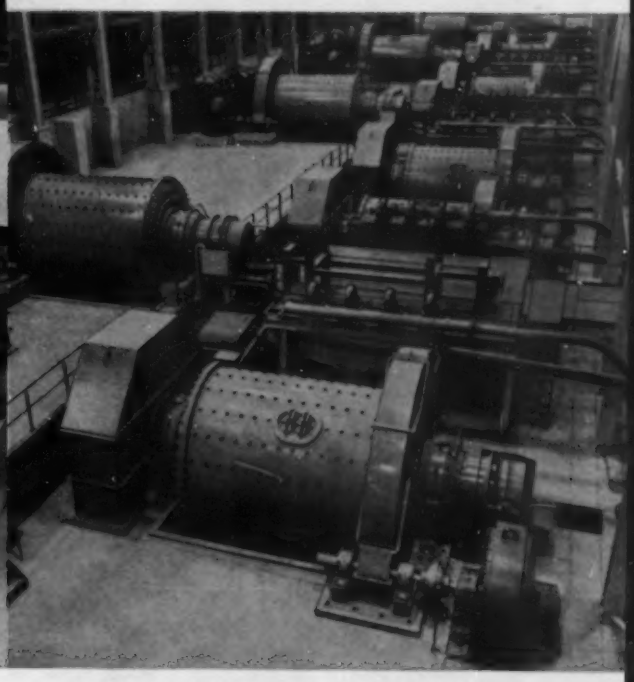


This Symons Primary Gyratory Crusher has a feed opening of 54" and capacity of 2000 or more tons per hour of hard, abrasive Taconite ore. Symons Gyratories are built in sizes up to 72" feed openings, with capacities of over 3500 tons per hour.

NORDBERG MFG. CO., MILWAUKEE,



Typical arrangement of Symons Cone Crushers and Symons Vibrating Rod Deck Screens installed for secondary and tertiary crushing, and screening of Taconite ore. Cone Crushers of this type are built in sizes up to 7′ diameter, with capacities to over 900 tons per hour.



Battery of four Nordberg 10½′ x 16′ Rod Mills and eight Nordberg 10½′ x 14′ Ball Mills installed in a large Taconite concentrating plant. Other Nordberg Grinding Mills are built in sizes from 6′ to 13′ diameter and up to 50′ in length in Rod, Ball, Pebble, Tube and Compartment types.

SYMONS . . . A REGISTERED NORDBERG TRADEMARK
KNOWN THROUGHOUT THE WORLD

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ORIGINAL SYMONS SCREENS NORDBERG

MACHINERY FOR PROCESSING ORES and INDUSTRIAL MINERALS

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A Size for Every Need...

in the only *Complete* Trailer Line

Athey-Cat PR21-DW21 maneuvers easily in tight quarters, handles big rock.

High-speed production on long hauls with the Athey-Cat PR15-DW15 Rear Dump.

Athey Hydraulic Ejection Trailer gives positive control in dumping and spreading loads.

ATHEY TRAILER FACTS . . .

Trailer-Tractor	Capacity
Athey PR21-Cat DW21	34-tons, 22.5 cu. yds.
Athey PR20-Cat DW20	34-tons, 22.5 cu. yds.
Athey PR15-Cat DW15	22-tons, 15.6 cu. yds.
Athey Hydraulic Ejection-Cat DW21 (or DW20)	31-tons, 22.5 cu. yds.
Athey PD20-Cat DW20	30-tons, 22 cu. yds.
Athey PH20-Cat DW20	45-tons, 62 cu. yds.

45-tons to 22-tons — rear dump, hydraulic ejection, side dump, bottom dump — matched trailers for Cat DW21, DW20 and DW15 Tractors — *only* Athey offers you this complete line of capacities and types of high-speed haul units.

Whether it's big rock, clay, ore, mud or earth you have to move, there's an Athey Trailer matched to your mining operations.

The most complete materials handling trailer line is built by Athey — the leader in the trailer field for more than 34 years. Each unit is built to the rigid standards of quality construction that mean longest life and low maintenance.

This is why Athey Trailers lead the field in big production, fast dumping, easier loading, more profits. Ask your Athey-Caterpillar Dealer for information on the complete line today. ATHEY PRODUCTS CORPORATION, 5631 West 65th Street, Chicago 38, Illinois.

THE *Complete* TRAILER LINE... *by the Leader*

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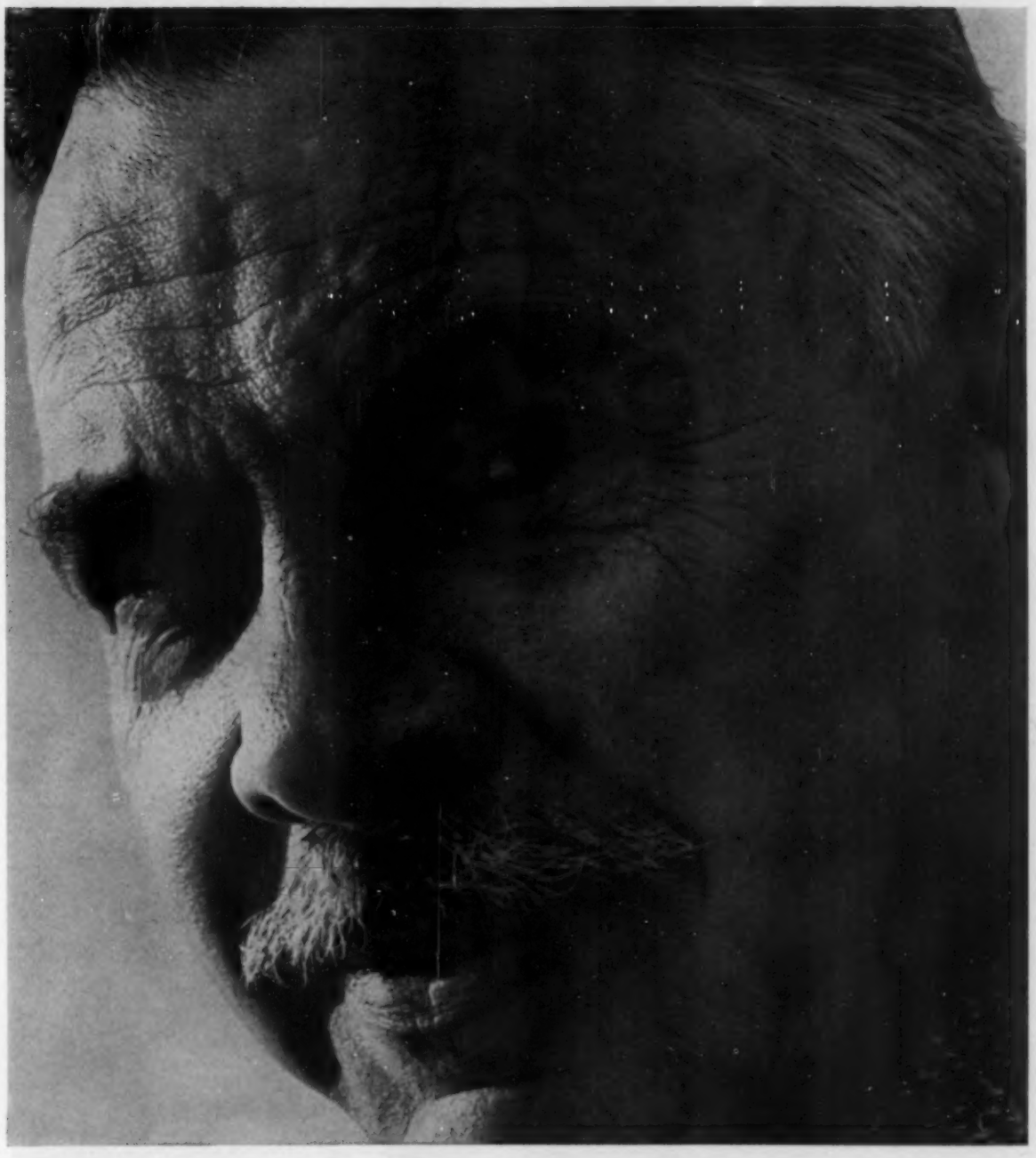
Just off the press — describes complete Athey Trailer line. Write today.

SEND FOR TRAILER BOOKLET



When your process calls for chemicals

talk to the man from Dow

YOU CAN DEPEND ON DOW FOR: XANTHATES • DOWFROTH® 250 • Z®-200 • SEPARAN 2610® • HYDROCHLORIC ACID • AMMONIA • CHLORINE
CAUSTIC SODA • VERSENE® • MAGNESIUM OXIDE • MAGNESIUM HYDROXIDE • ION EXCHANGE RESINS • SOLVENT EXTRACTANTS

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN DOW

New Mexico: close-up of uranium filtering operation at Blue Water Plant of The Anaconda Company.

On these filters Separan 2610 more than doubled mill throughput

Another production problem solved with the new high-speed flocculant, Separan 2610

Previous to using Separan 2610® as a flocculant, this southwestern uranium processor undertook what seemed to be an impossible task. He wanted to double tonnage throughput without adding filtering or thickening equipment.

This processor tried the "old stand-by" flocculants, but could get neither the desired flocculation speed nor thick enough filter cakes that would discharge easily. To accomplish his goal seemed impossible . . . until he talked to the man from Dow and applied the new and different flocculant, Separan 2610.

Here are the results:

Ore	Before Tons/Day	After Tons/Day
Very slimy	50	400...at 1.0# Separan/T
Blended	200	450...at 0.6# Separan/T
Blended	250	500...at 0.5# Separan/T
Good limestone	350	500...at 0.15# Separan/T

You'll notice that with Separan 2610, average filtering rate of the various ore compositions *more than doubled!* This is no phenomenon. Separan 2610 has proved itself with practically every mineral mined. In several mills, it has even tripled production rates!

Easy to prepare and apply

Being a synthetic organic polymer, every order of Separan 2610 provides the same uniform quality. It adds no excess bulk, is effective in both acid and alkaline circuits. Stock solution requires no heat or preservative; a disperser enables you to prepare large amounts without a mechanical mixer.

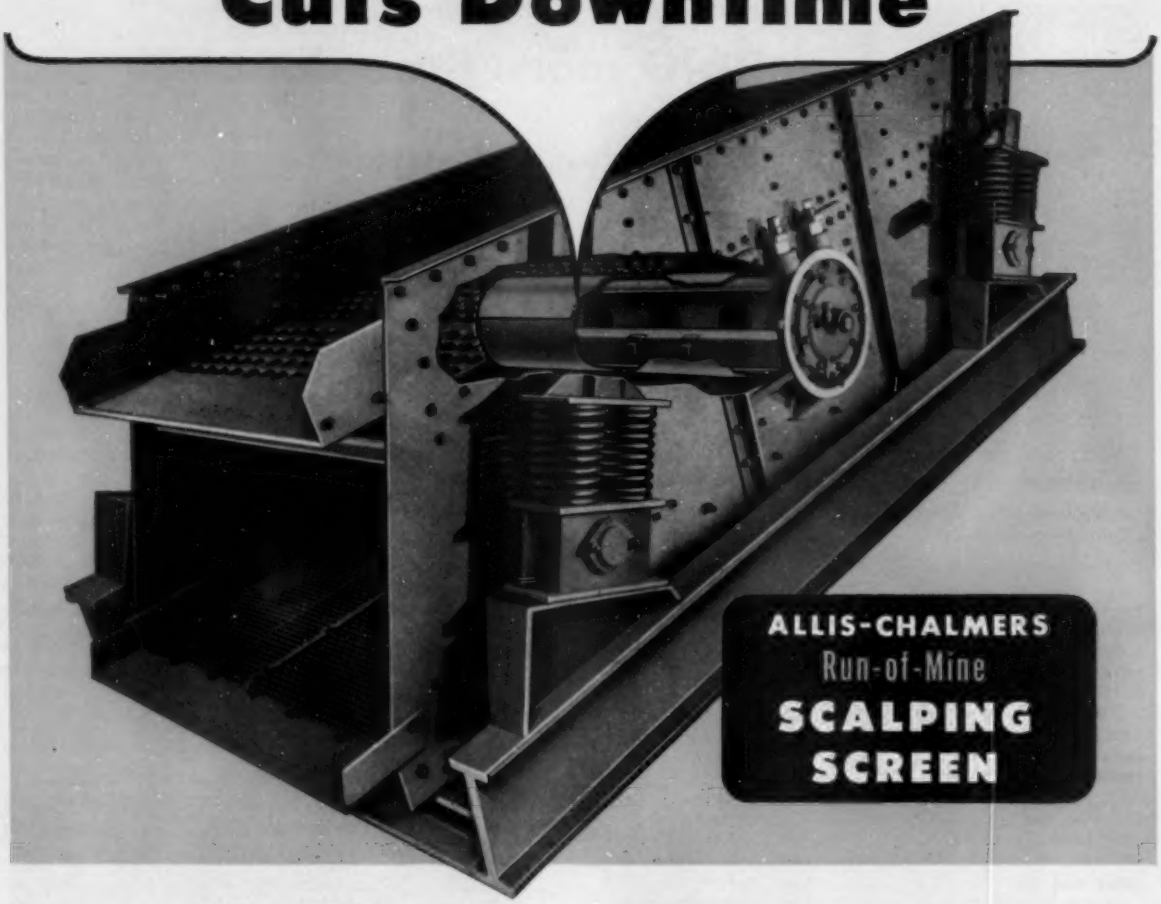
For faster settling, improved filtration, reduced loss in overflow—try this revolutionary flocculant yourself. Available from three f.o.b. points: Midland, Michigan; Pittsburg, California; and Velasco, Texas . . . and from two stock points: Port Newark, New Jersey, and St. Louis, Missouri. Samples, technical assistance and results more specifically related to your type ore can be obtained through your Dow man. Or write us direct. THE DOW CHEMICAL COMPANY, TECHNICAL SERVICE AND DEVELOPMENT, Midland, Michigan, Dept. SE 1316B.

When your process calls for chemicals, talk to the man from Dow

XANTHATES • DOWFROTH® 250 • Z®-200 • SEPARAN 2610® • HYDROCHLORIC ACID
AMMONIA • CHLORINE • CAUSTIC SODA • VERSENE® • MAGNESIUM OXIDE
MAGNESIUM HYDROXIDE • ION EXCHANGE RESINS AND SOLVENT EXTRACTANTS

YOU CAN DEPEND ON DOW

Replaceable Cartridge Mechanism Cuts Downtime



CHANGING this screen mechanism is as simple as changing a battery in your car. All you do is remove four bolts and slide out the entire mechanism.

The cartridge mechanism gives you the added advantage of taking it to your maintenance bay or shop where all facilities are handy and maintenance costs are lowest.

If your process involves a multiple installation, it is highly profitable to keep a replacement mechanism in reserve. Slip one out, slide another in. Keeping production flowing is as easy as that.

Other Maintenance-Reducing Features

The proven simplicity and record-low maintenance of two-bearing design . . . largest, most sturdy bearings ever installed on a vibrating screen . . . multiple (two sets per corner) steel support springs that prevent transfer of vibration to structure even when materials stick to screen . . . sealed-in mechanism with single grease seal on drive side that eliminates multiple possibilities of dirt infiltration — all these features keep maintenance cost low.

For complete information, see your nearby Allis-Chalmers representative or write for Bulletin 07B8368. Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

A-5194

ALLIS-CHALMERS

- Greater Safety
- Increased Production

Fluorescent Lighting Underground

Supplementary underground lighting with new approved fluorescent fixtures is expected to result in reduced loss of material and supplies, less abuse of equipment, better housekeeping, improved supervision, less worker fatigue, and better morale.

First permissible systems for illuminating underground working areas, other than the miners cap lamp, have been authorized by the U. S. Bureau of Mines.

Two new USBM Approvals (29-1 and 29-2) cover fluorescent mine lamp fixtures, cables, cable connectors, and distribution panels with circuit breakers. The new systems are designed to provide supplementary illumination, principally at the working face, to make operations safer and more efficient.

"Lack of adequate illumination in coal mining working areas has contributed to many accidents and hampered production," said M. J. Ankeny, director of the Bureau. "And the hazards have increased with spreading mechanization. Until now, however, the fire and explosion risk created by supplementary lights drawing current from mine electrical circuits has outweighed the hazards caused by poor visibility." Use of the system, he said, should mean "fewer accidents and greater productivity in the most hazardous underground areas."

Bureau standards for safe mine lighting were set one year ago, after a prolonged study.

Two variations of an approved system have been developed by Mine Safety Appliances Co. One consists of an ungrounded, isolated two-pole circuit (two-conductor cable), while the other comprises a grounded three-pole circuit (three-conductor cable). Both systems operate on a 60-cycle, 118-v single phase supply. When 440 v or 220 v current is provided underground, a transformer is used to step down the voltage. This also provides the isolated circuit for the ungrounded system.

Major feature of both systems is the M-S-A fluorescent lamp fixture. Lightweight and compact for easy portability, the lamp is equipped with instant circuits that have been proven safe under all ventilation conditions in gassy mines. Even if broken in an explosive mixture of methane and oxygen, the fixture will not cause an explosion.

Each fluorescent lamp has a permanently wired 3-ft length of flame-resistant cable. Single lights draw approximately 0.6 amp at 118 v for each 30 lights connected on a 20-amp circuit.

Test Results

The permissible system was tested extensively at a large coal mine employing conventional room and pillar methods. Average height of the seam was 6 ft. During the test, which lasted more than a year, there were no accidents in the section illuminated by the system. Ten accidents occurred in the other five sections operated.

The section served by the supplementary lighting also produced more tons of clean coal per manshift than the other five, and handled the largest amount of impurities. Total production tonnage of the lighted section was 17 pct above that of the next highest section.

High purity iron ore (68 pct Fe) from the Bomi Hills of Liberia is loaded by conveyor belt aboard a Republic Steel Co. vessel at Monrovia for shipment to the U. S. Liberian surveys indicate a possible ore reserve of more than a billion tons. Exports in excess of six million tons annually are deemed possible within the next five years; 1956 exports exceeded two million tons. A new Bomi Hills beneficiation plant, to be completed in August, should yield an additional million tons a year.

This Bucyrus-Erie 40-R is helping to raise production standards at a large open pit copper mine in western U.S.

This Bucyrus-Erie 40-R drills 9-in. holes through leached granite and a pyrite orebody containing copper.

Drilling 9-in. holes at an open pit copper mine, this Bucyrus-Erie 40-R puts down 5 times as much footage as cable tool drills previously used.

Bucyrus-Erie Rotaries Win Strong Approval in the Pits

"Enormously pleased. The 40-R surprised everybody favorably."—Copper mine operator.

"The 50-R drills do as much in one hour as a cable tool drill does in a shift."—Machine operator at a large open pit mine.

"The 40-R solved what seemed an unsolvable drilling problem by producing the necessary speed to stay ahead of the 150-B shovel."—Assistant manager of a large copper mine in western U.S.

These and similar comments are typical of the high regard owners and operators have for Bucyrus-Erie rotary blast hole drills. Since the first Bucyrus-Erie rotary was put into operation over four years ago, both the 40-R and 50-R have shattered old footage records in location after location.

There are good reasons for the popularity of Bucyrus-Erie rotaries. They offer *maximum controlled penetration* through hydraulically powered down pressure on the bit. They also provide *the most efficient drilling speed for a given formation* because of Ward Leonard electric control on rotation of the drill stem. *Hole may be drilled continuously* for the full length of a drill pipe—32 ft. 9 in. on the 50-R, 27 ft. 9 in. on the 40-R.

Bits are cooled by compressed air, and compressed air is used to remove cuttings: fine cuttings are picked up and handled by a Roto-Clone precipitator; heavies pile up adjacent to the drill hole for use as stemming material. *Manual effort is eliminated* for adding or removing drill pipe because of a remote-controlled power-driven drill pipe rack.

Let us tell you more about the speed and economy of Bucyrus-Erie rotary blast hole drills—the 40-R for drilling 6¾- to 9-in. holes, and the 50-R for drilling 9⅞- to 12¼-in. holes. Write today for detailed, illustrated literature. 53857C

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REAGENT NEWS

"ore-dressing ideas you can use"

For Silica Flotation or Slime Flocculation-- AEROMINE® 2026 Promoter

Originally developed and manufactured for Cyanamid's own Florida phosphate operations, AEROMINE 2026 Promoter is an economical silica or silicate flotation collector and is also valuable as a flocculant for fine clay slimes to improve settling and filtration rates.

At Cyanamid's phosphate operations, rougher concentrates floated with crude tall oil contain considerable silica. These concentrates are washed with dilute sulfuric acid to remove the fatty acid coating prior to the silica float. In the cleaner circuit, 0.2 pounds per ton of AEROMINE 2026 with 2.0 pounds per ton of kerosene are used to float off the silica.

As a flocculant at a non-metallic operation producing clay minerals, 0.3 to 0.5 pounds of AEROMINE 2026 per ton of dry solids improve the filtration rate of slimes as much as 35%.

Here are the properties of AEROMINE 2026 Promoter:

Color	– Dark brown
Consistency	– Viscous paste
Specific Gravity	– 0.96
Solubility	– Water-soluble–5% solutions recommended. Also soluble in kerosene and alcohol frothers.

For a sample of AEROMINE 2026 Promoter for trial in your own laboratory, fill in the coupon below.

Please send me a free sample of AEROMINE 2026 Promoter.

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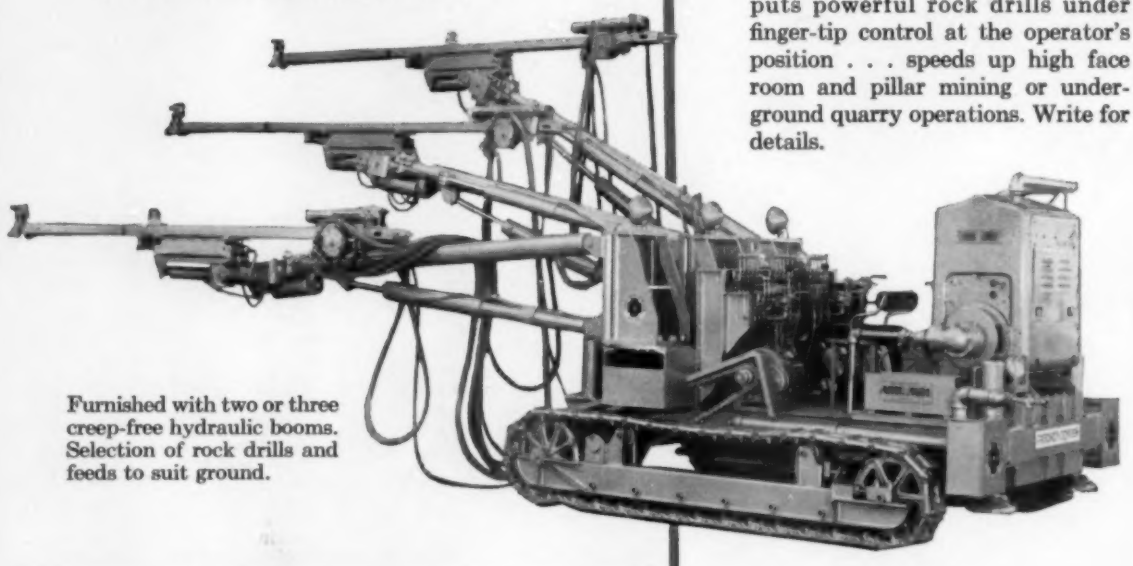
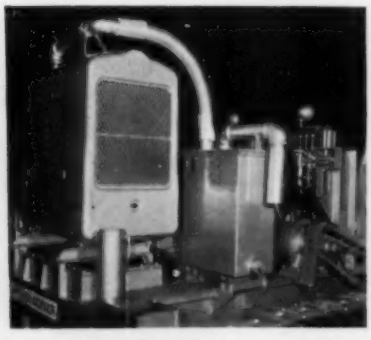
A new way to make man-hours more productive in your mine

THE NEW GARDNER-DENVER
JMT "MOBILJUMBO"®

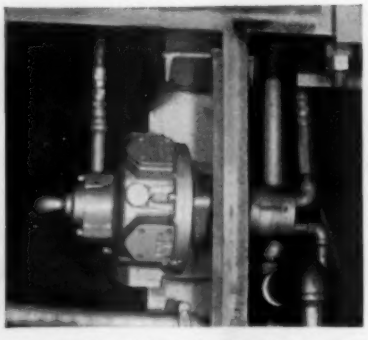


Furnished with two or three creep-free hydraulic booms. Selection of rock drills and feeds to suit ground.

"Push-button" rock drilling with the new Gardner-Denver JMT "MOBILJUMBO" offers new opportunities to increase productivity with less effort. The new JMT self-propelled, crawler-mounted jumbo puts powerful rock drills under finger-tip control at the operator's position . . . speeds up high face room and pillar mining or underground quarry operations. Write for details.



Available with diesel-hydraulic drive to the crawlers, or with crawlers powered by 5-cylinder radial air motors.



Air motor drives hydraulic pump for remote hydraulic control of boom and drill positioning by one man.

Electric generator, air motor driven, supplies three lights that flood working face, light drilling operations.

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IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

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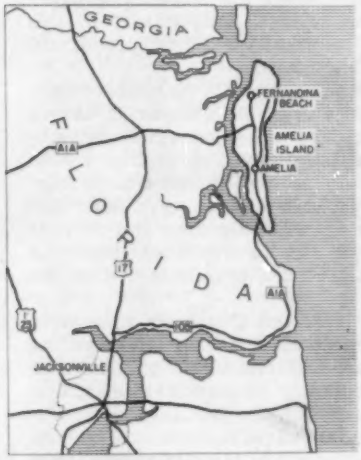
Titanium Mine for Island Off Florida

Sands of an island off the coast of Florida will be worked for their titanium content in a Union Carbide & Carbon Corp. mining project scheduled to start in the spring of



Titanium sands will be dredged south of Fernandina Beach.

1958. Plans call for the construction of a processing mill and auxiliary equipment to begin shortly.

Reserves of heavy minerals have been found economically adequate on a 3000-acre tract held by the company on Amelia Island, 30 miles northeast of Jacksonville. The area, south of Fernandina Beach, on the 20-mile-long island was drilled during the last two years in an exploration program carried on by a company division, Union Carbide Ore Co. Minerals that were found include ilmenite, rutile, zircon, and monazite.

Mining will be done by a bucket-ladder dredge capable of handling sand at 500 tph. Wet concentration will be done on the dredge. Concentrates will be transferred and trucked to the projected dry mill for electrostatic and magnetic separation.

As mining progresses, tailings will be deposited at the rear of the dredge and the mined-over land restored and replanted. Fifteen tons of heavy minerals are expected to be recovered from each hourly working of 500 tons. Three shifts will work seven days a week. A total of 85 workers will be employed.

The titaniferous minerals will be shipped to Electro Metallurgical Co., another division of Union Carbide, for the production of titanium sponge. Electromet's new plant at Ashtabula, Ohio, is the largest sponge producer in the U. S. Production is now at full capacity of 7500 tons per yr.

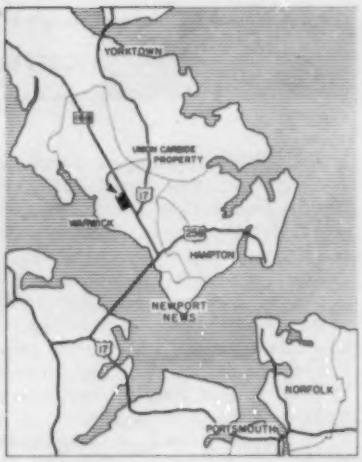
Virginia to Have Import Ore Plant

Processing of manganese and chromium ores from foreign sources is the use projected for a new ore preparation plant by Union Carbide & Carbon Corp. at Warwick, Va., announces M. G. Dial, president.

The new plant will be operated by a division, Union Carbide Ore Co., and will grade and classify approximately 30,000 tons of ore monthly. Unloading facilities will be able to handle ocean-going cargoes, at the rate of about 500 tph. Ore will be shipped from Warwick by rail to plants of Electro Metallurgical, another division, for use in the production of steel mill alloys.

Ground breaking will take place in the early fall of this year and operations are scheduled to begin on a limited scale in the spring of 1958.

Principal reason for building in

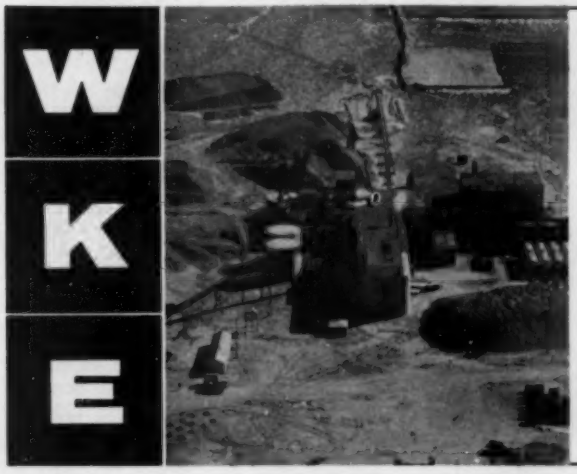


Location of new ore processing mill at Warwick, Va.

this area, announces Union Carbide, is the availability of extensive dock facilities nearby and ready access to rail facilities. Chesapeake & Ohio Railway, which serves the area, has just built a large bulk materials import pier at Newport News for handling greater tonnage of ore and other commodities.

NOTE

A limited number of copies of *Mining Branch Abstracts*, prepared for the AIME Annual Meeting in New Orleans, Feb. 24-28, 1957, are still available. Copies can be obtained by writing to Arnold Buzzalini, Society of Mining Engineers of AIME, 29 W. 39th St., New York 18, N. Y., and enclosing 50¢. Please indicate your Divisional interest at the time you order.



At Shiprock, New Mexico, for

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...their Navajo Uranium Extraction Plant.

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POINTING up copper's 7 pct excess of production over consumer demand in 1956, the president of Phelps Dodge Corp., R. G. Page, had some soothing words for the present low state of copper at the annual meeting of his corporation.

The general situation, he said, is that "for a period of some nine months, since the middle of last year, we have had declines in price and accumulation of modest stocks in the hands of producers. It is believed, however, that the decline in consumption, at least in this country, is not as large as would be indicated by the increases in producers' stocks. True consumption is no doubt greater than indicated consumption, as unquestionably there has been considerable liquidation of inventories by users of copper products. That process of inventory liquidation inevitably accompanies a period of falling prices.

"Consumption of copper is closely related to the rate of activity in the durable goods industry. That rate remains high, though consumption of copper, as measured by deliveries by fabricators, shows a decline in relation thereto in recent months. It therefore appears that inventories in the hands of users of copper will need replenishment at some point.

"World consumption of copper will continue to grow, though each year cannot be expected to set new records. Adjustments are to be expected from time to time, probably especially following a period of unusually high prices such as we have recently experienced."

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LEAD consumption by use in construction is the fourth largest outlet for the metal, and accounted for 118,000 tons in 1955. But, as R. H. Cutting of the Bunker Hill Co. pointed out at the recent meeting of the Lead Industries Assn., lead in construction has actually decreased in the last 30 years.

While the last five years have shown an upturn from the 106,000 tons consumed in the years between 1950 and 1954, the 1955 figure is below the 123,000 tons per yr used 30 years ago.

Pointing out that it is anticipated that the population will increase by 16 pct during the next ten years with a resultant 30 pct increase in consumer goods and service expenditures, Mr. Cutting went on: "The question we are all interested in is whether we in our industry will keep abreast of this expanding economy or whether we will be outside looking in."

Items included in the construction field embrace: residential construction—hotels, apartments, private dwellings; public buildings of all kinds—offices, government facilities; industrial construction—factories, manufacturing facilities, smelters and refineries, acid and chemical plants, and others. But Mr. Cutting says, "there are too many in the industry to whom the long range economies offered by lead do not offset the initial higher investment that is usually encountered. . .

"Surprisingly, though, lead is holding a relatively good position in the residential and general building fields in spite of this situation. Although many efforts have been made to eliminate the cast iron and lead plumbing waste system, there is an intelligent and determined resistance to substitution in this phase of plumbing, principally from the standpoint of protecting the public health."

"Aside from actual plumbing," he adds, "there is a field which has not yet been explored, but in which some interest has been expressed from various quarters, in the use of hard or antimony lead sheet for roofing and flashing. If this can be kept within the weight of 2½ to 3 lb per sq ft, hard lead is today competitive with 16-oz copper and there is a good deal to be said as to why lead should be given preference under such a competitive condition."

While some feel that lead producers may have been slow to fully meet the challenge of substitute materials in the chemical industry, "progress has been made in producing improved lead alloys, methods of application, and the designing of equipment and processes so that lead has not only held its own in many phases but has in some instances taken good hearty strides as well."

Looking to the future the warning to the lead industry was clear—". . . if our industry is going to stand still, we will see markets in the construction fields increasingly fall away from us, because changing times demand corresponding changes in products.

"However, if we aggressively approach this problem of declining markets through research and product development, both independently and as an Association, we should always be able to capture new markets to offset those lost through conditions beyond our control."

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PURCHASING agents were recently coached on the subtle points of the aluminum market and its outlook by R. L. Sheneman, analyst for Kaiser Aluminum & Chemical Sales Inc. He said that last year's 3 pct climb in shipments in the face of certain recent unfavorable trends (sagging residential construction, production cuts in automobiles, downward turn in sales of consumer durable goods) "reflects an underlying growth of new applications which more than offset declines in some of aluminum's principal markets. We feel that this underlying strength in demand supports the forecast that the aluminum industry will continue to grow. . . . The aluminum industry is giving evidence each day of its increasing awareness of operating, for all practical purposes, in a permanent buyers' market.

"Concerning the immediate future, we expect aluminum shipments to rise by 5 to 10 pct during 1957. . . .

"Statements of existing and planned capacity in the free world outside of the U. S. indicate an expansion by 1960 sufficient to raise annual consumption to a point about 50 pct above the level in 1955. A possible insufficiency of supply is pointed up in these plans by the fact that consumption of primary

aluminum doubled in the free world outside our country from 1950 to 1955. In the period from 1950 to 1955, when the consumption of aluminum in the U. S. was rising about 65 pct in mill shapes and castings, consumption in free Europe was more than doubling; and in Asia, Australia, and South America the rate of growth was even more rapid. Whether or not such growth rates will continue abroad is, of course, difficult to say; but the maintenance of anything like the high rates of increase in the consumption of aluminum in these free world countries would of course lead to a change in the current supply-demand situation abroad. The chances of vigorous growth in the usage of aluminum in the free world appear quite good. . ."

Domestic stocks of the metal are presently in excess of demand. But, Mr. Sheneman indicates, "It is entirely normal and, in fact, desirable that aluminum should be in adequate supply at all times. . . . The fact that over the next few years the supply of our metal in this country will be relatively ample is giving aluminum users engaged in product research additional impetus to design their products to utilize greater quantities of aluminum. It is true that technology sets the limits within which one metal or material can replace another, and it is equally true that all metals in general share in the advance of technology. However, we believe aluminum will be favored increasingly in the future."

On the basis of results obtained by a market research survey by Kaiser Aluminum, he says, "we expect the demand for aluminum will more than double over a period of the next decade to a level of about 8.4 billion lb by 1965."

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LATIN America's huge potential reserves of industrial minerals and fuels are largely undeveloped, according to the latest report compiled by the Chase Manhattan Bank. Systematic surveys have so far been confined to the coastal fringe.

Although manufacturing in the area increased 60 pct between 1946 and 1954, output of basic industrial minerals rose only 27 pct. At the same time, local consumption has increased. The minerals and fuels deficit is especially serious in Argentina and Brazil.

In reality, minerals development offers many Latin American countries their best economic opportunity. Demand for minerals is closely allied to the growth of world industrial production, which has recently been rising 6 pct each year. By expanding their volume of mineral exports, these republics could obtain the foreign exchange funds needed to buy machinery and equipment for economic development. The minerals trade balance is very favorable to Venezuela, Peru, Mexico, Chile, and Bolivia.

However, most of the 20 Latin American republics do not have the initial capital to invest in large-scale mining developments. Major minerals projects have been financed by U. S. capital. With the exception of two mining complexes that originated before the first World War, all the major old deposits operating today were developed by U. S. concerns. U. S. private mineral investment in Latin America, exclusive of petroleum, was $1 billion in 1954, double that of 1946. The greatest percentage increase was in Peru, where U. S. investment rose from $44 million to $171 million. In Mexico, U. S. investment increased 28 pct from 1946 to 1954. Total U. S. private investment in Latin America was more than $9 billion at the end of 1955.

There has been little expansion in nations where barriers have been raised against foreign investment. Any measures designed to encourage the foreign investor should lead to substantial rewards in higher national income and improved standards of living. Evan Just, vice president of Cyprus Mines Corp., urges developing countries to take advantage of such opportunities (see page 641).

Eight Latin American nations produce most of the area's combined volume of 15 basic minerals. In the years between 1946 and 1954, the greatest progress was made in Peru, Venezuela, Brazil, and Cuba. Peru's output rose 170 pct. Venezuela, which had no major nonfuel mining before World War II, became Latin America's leading iron ore producer. Brazil's output tripled, mostly through expansion of iron ore, but even this is a small proportion of the nation's vast potential. Cuba expanded its volume by 23 pct, chiefly in output of nickel and manganese. Bolivia's tin production, however, has declined since the mines were nationalized, and Chile's volume rose only 3 pct.

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TOTAL free world nickel-producing capacity is expected to reach 650 to 675 million lb in 1961 according to an estimate voiced by J. F. Thompson at International Nickel Co.'s annual meeting. Justification of the prediction would mean a rise of some 50 pct over the record 1956 total.

"Assuming defense demand remains at its present level and that nickel is not taken in 1961 for government stockpiling," he added, "the 1956 rate of world civilian consumption of nickel will have to be increased by more than 75 pct in order to absorb the output resulting from the expected expansion in nickel-producing capacity. It is evident that a huge new demand must be stimulated."

Long-range research and development of uses and markets is necessary if nickel is to meet the challenge of other alloying materials and that of wood, glass, and plastics, Dr. Thompson has indicated. "The industry must in the years ahead be even more aggressive in striving to reduce costs and in preparing itself for the time when the upward trend of nickel prices is stopped or even turned back."

International Nickel's Moak Lake project in Manitoba will comprise a large portion of world capacity upon its initiation in 1960. Scheduled production rate is 60 million lb per yr.

PEAK CAPACITY

with

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General View of Plant Showing KVS 10′ x 150′ Kiln with Preheater Internal Recuperator and Preheater

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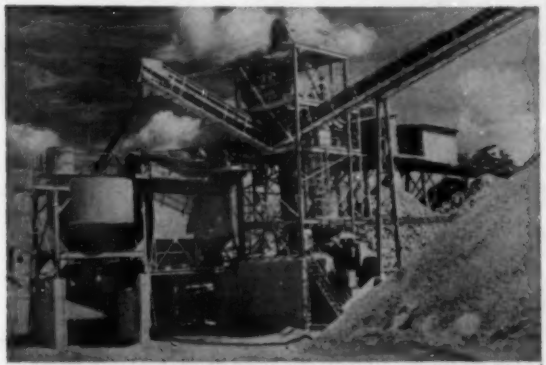
...for New Braunfels, Texas plant of United States Gypsum Company

LIME PLANT PRODUCTION BEYOND RATED CAPACITY

One of America's largest lime producers, United States Gypsum Company chose KVS design and equipment for their new plant at New Braunfels, Texas.

Machinery and equipment designed and furnished by KVS includes crushers, screens, conveyors, kilns, preheaters, deheaters. The installation also provides the latest automatic controls and special equipment that permits high temperature "aging lime" — important in achieving highest quality. Also, storage capacity at this plant has been almost tripled.

Whether your plant is large or small, old or new, Kennedy has the machinery and equipment for better products at lower cost. Let us prove . . . with operating facts . . . why KVS machinery is your best buy. Engineering consultation, anywhere, any time.



UNITED STATES GYPSUM CO., NEW BRAUNFELS, TEXAS — STONE PREPARATION PLANT COMPRISING KENNEDY 37½ S GEARLESS CRUSHER, KENNEDY AAA VIBRATING SCREEN AND KENNEDY BELT CONVEYORS

UNITED STATES GYPSUM CO., NEW BRAUNFELS, TEXAS — CLOSE-UP VIEW SHOWING INSTALLATION DETAILS OF KVS 10′ x 150′ ROTARY KILN, PREHEATER, RECUPERATOR AND DEHEATER

UNITED STATES GYPSUM CO., NEW BRAUNFELS, TEXAS — OVERALL VIEW OF STOCKPILE SHOWING OPERATION AND ARRANGEMENT OF CONVEYORS

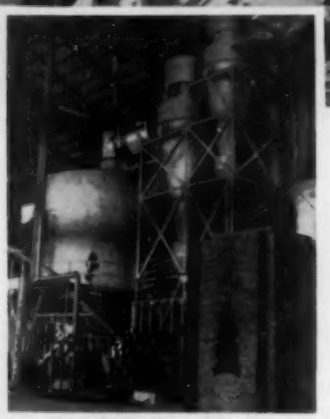
Dowa Mining's Kosaka hydro-metallurgical plant where Dorrco FluoSolids System roasts 83 metric tons of complex copper-zinc concentrates per day.

Fluidization — key to maximum utilization in Japan

Processing copper bearing pyrrhotite ore, the Dowa Mining Company at the Okayama, Japan plant is producing . . . and all from the same raw material . . . sintered iron ore for blast furnace use, cement copper and sulphuric acid.

Of major importance in this unique installation is the Dorrco FluoSolids System, consisting of two 20 ft. dia. Reactors plus auxiliary equipment. Utilizing the proven principles of fluidization, the crushed raw ore is roasted under controlled conditions in the System providing SO_2 gas for contact acid manufacture. Roaster calcine is acid leached for copper recovery and leach residue is sintered as blast furnace feed.

The Dorr-Oliver research, design and engineering staffs and our Associates in Japan, Sanki Engineering Co. Ltd., of Tokyo, have collaborated with Dowa Engineers before. At Dowa's hydro-metallurgical plant in Kosaka, Japan, Dorrco FluoSolids System is a prime factor in the world's first successful roasting of copper and zinc with electro winning of both metals. In the Okayama installation as at Kosaka, manufacture of the FluoSolids Reactors and a number of components in Japan with auxiliary equipment furnished from the U. S. proved to be most advantageous to Dowa.



One of two 20 ft. dia. FluoSolids Reactors roasting 235 metric tons per day of crushed pyrrhotite ore at Dowa's Okayama Plant.

This is but another example of how the flexibility of the Dorr-Oliver Worldwide engineering organization can work to the advantage of a client. It can work for you . . . For detailed information on D-O equipment and services involving the separation of finely divided solids in suspension or fluid techniques, drop a line to Dorr-Oliver Inc., Stamford, Connecticut.

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2. Reduced Inventory — You don't have to tie up funds and warehouse space with spare motors and replacement parts. The A-C Distributor is your motor storehouse.

3. Continuous Production — Your A-C Distributor can deliver a motor to your shop in a matter of hours. (And, once you order an A-C motor, you're sure of 'round-the-calendar operation.)

GET ACQUAINTED with your Allis-Chalmers Motor Distributor soon. You can find out his name by contacting the A-C sales office in your area, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

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CATERPILLAR ANNOUNCES

NEW DW15 (SERIES E) AND NEW No. 428 LOWBOWL SCRAPER

The No. 428 LOWBOWL Scraper

The DW15 (Series E) Tractor

Here's a new Cat team loaded with features that add up to one thing—A HIGHER PRODUCTION RETURN ON YOUR INVESTMENT. See your Caterpillar Dealer for details on this great team's performance.

GET THE STORY IN BRIEF ON THE OPPOSITE PAGE

A GREAT TEAM: The performance of the DW15 (Series E) Tractor and No. 428 Scraper can be summed up simply: bigger loads—faster.

FACTS ABOUT THE DW15 (SERIES E) TRACTOR

Around the world, the DW15 has proved that it can move material faster and more profitably than competitive machines in its class. Now there's a new DW15 (Series E) to give you even higher production. This is the story:

ENGINE: A new Caterpillar D326 Engine, designed especially for the DW15 (Series E), develops 200 HP (maximum output capacity).

And Caterpillar research has produced a 23% torque rise in this new engine! This means that high tractor rimpull is maintained through a wide range of travel speeds in each gear, and the need for gear changing is decreased. In fourth gear, for example, over 3,000 pounds of rimpull are delivered at travel speeds from 9 MPH all the way to 18 MPH. A new engine, yes—but with these traditional Caterpillar advantages: uses inexpensive No. 2 furnace oil without fouling; needs no fuel system adjustments; requires no cleaning of fuel injection valves.

TRAVEL SPEED: The DW15 (Series E) offers ten speed selections, from 2.7 to 37.2 MPH. But, more important, it provides four-wheeled sure-footedness—*the ability to use the speed on the job.* Operators ride with more comfort, feel greater stability. They travel faster, and in safety.

MANEUVERABILITY: Four-wheeled stability means faster cycle time because the DW15 (Series E) can make short radius turns at higher speeds. It can turn without stopping inside a 35-foot diameter and in a smaller area through use of a turn-back-turn maneuver.

VERSATILITY: The DW15 (Series E) provides versatility that far surpasses similar sized two-wheeled machines. It can be unhitched from its scraper and used as an independent unit to tow compactors, water wagons or other units, and it can be teamed with the Athey PR15 Wagon for rock hauling work.

FACTS ABOUT THE No. 428 LOWBOWL SCRAPER

CAPACITY: Struck—13 cu. yd.; heaped—18 cu. yd.

ADVANCED DESIGN: There is more to Caterpillar's exclusive LOWBOWL design than a low bowl profile. Width and length proportions are designed to give maximum loading efficiency. And every component—particularly the apron, ejector, cutting edge—is likewise designed to do its part in achieving capacity loads.

LOADABILITY: The final result of this careful engineering is this: bigger loads—faster. LOWBOWL design gives the new Caterpillar No. 428 Scraper a faster loading rate because incoming material meets less material resistance and less friction from the load already in the bowl. While other scrapers are still in the cut struggling for the last few yards of their load, the new Cat units are on their way to the fill—with big pay loads!

NEW FEATURES: Outstanding new features of the No. 428 include: increased ground clearance—for high-speed travel in rough going; increased apron lift—for faster ejection of any material; large area pushblock—for better pusher contact.

NEW TIRES FOR THE DW15-No. 428

Both the CAT* DW15 (Series E) Tractor and No. 428 Scraper feature 26.5-25 wide-section tubeless tires—the product of extensive co-operative research by Caterpillar Tractor Co. and leading tire manufacturers. Tubeless tires offer load-carrying capacity comparable to conventional tires at a *reduced inflation pressure.* This gives better flotation and traction while decreasing rolling resistance. The wider tire treads take a "grouser like" bite, making more efficient use of engine horsepower. And tubeless tires eliminate 80% of the down time caused by tire failure.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

CATERPILLAR*

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ONE GOAL: To concentrate our capabilities, resources and experience on the design, manufacture, distribution and service of job-tested heavy equipment.

How a midwest steel producer

TRIPLED TRACTOR-SHOE LIFE

It's "tough-going" in a slag pit! Heavy loads, the grinding impact of abrasive rock and metal, really put tractor shoes to the test. And that's exactly what this steel producer did.

Amsco® cast Manganese Steel Tractor Shoes were installed in place of rolled shoes. The result: *a 3-time increase in service life.* While rolled shoes had previously been replaced after one season's service, the Amsco pads lasted nearly *3½ years—a total of 3374 service hours.*

Here's further proof that Amsco Manganese Steel—"the toughest steel known"—can save you money and replacement time wherever severe impact and abrasion are a problem. Call your nearest Amsco representative, or write us direct, for further information on Amsco Tractor Shoes.

Amsco Manganese Steel Tractor Shoes
In addition to excellent impact and abrasion resistance, Amsco Tractor Shoes have countersunk bolts. This means less wear on bolts, often saves bolt-replacement when changing pads.

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division • Chicago Heights, Ill.

OTHER PLANTS IN: DENVER, LOS ANGELES, NEW CASTLE, DEL., OAKLAND, CAL., ST. LOUIS, JOLIETTE, QUEBEC

A Salute to AIME's Mr. Transactions

Ezra J. Kennedy, Jr. Retires

One of the best known members of AIME stepped down from full-time activity on May 1. Mr. Ezra J. Kennedy's retirement was marked by many expressions of appreciation for his 30 years of service to the Institute from AIME officers and members whom he counts among his host of friends. Numerous resolutions to this effect were passed at business sessions of committees during the Annual Meeting, and at informal gatherings of individual members.

At the Joint Meeting of the AIME Executive and Finance Committees on April 15, a resolution honoring Mr. Kennedy was unanimously voted. (See text of resolution below).

These sentiments showing the affectionate regard in which Mr. Kennedy is held were also echoed at the luncheon in his honor on April 30, at the Brass Rail Restaurant in New York, attended by the entire AIME staff. Each department head publicly thanked Mr. Kennedy for his courtesy, patience, and generous assistance. These qualities also proved invaluable to the thousands of authors with whom he worked closely, all of whom found his innate tact bespoke a true gentleman of the old school.

Associated with the Institute since 1925, Mr. Kennedy has been successively Assistant to the Secretary, and since 1944, an Assistant Secretary, During these years he devoted his efforts primarily to the techincal publications, working on every volume of *TRANSACTIONS* from 1925 to 1949. To members of the Institute he was *Mr. Transactions*. In addition to Transactions he handled at least part of the job on most of AIME's books issued during these years, guiding committees in maintaining a high standard of quality. He also found time for many of the details of Annual Meeting organization, and set up the programs for publication.

Ezra J. Kennedy, Jr., is a native of Detroit where he was born on Apr. 1, 1887, to Ezra, Sr., and Nellie Kennedy. A graduate of the University of Michigan, he married Helene L. Euler, who passed away in 1944. Since 1949 he has been happily married to the former Madeline D. Beekman.

After working as a chemist for Charles F. Pfizer & Co. and later with the Air Reduction Co., "E. J." accepted a position as market reporter on the staff of the New York *Journal of Commerce*. This led to the post of associate editor on the *Oil Trade Journal*. In 1921 he joined the publicity and statistics department, American Petroleum Institute, leaving to begin his long and happy association with AIME.

Although Mr. Kennedy will be editor and handle the publication of various conference *Proceedings*, he will have the opportunity for more time for his favorite hobby. The Kennedys find driving their car through the countryside and enjoying the changing landscapes their most satisfactory form of relaxation. Everyone at AIME wishes them happy motoring under fair skies.

Resolution in Honor of

EZRA J. KENNEDY, JR.

WHEREAS, the Board of Directors of the American Institute of Mining, Metallurgical, and Petroleum Engineers takes note that Assistant Secretary EZRA J. KENNEDY, JR., will retire April 30th, 1957, after thirty-one years of devoted service,

RESOLVED, that the Board of Directors commends Ezra J. Kennedy, Jr., for his faithful, unassuming performance as secretary of the Institute Technical Publications Committee; and that the Board of Directors particularly recognizes his success in maintaining the high quality of the Institute's Transactions while winning the respect and friendship of thousands of authors.

April 15, 1957

GROVER J. HOLT, President

They close tight...

...They open easily!

Air operated DeZurik Valves on an Eimco Burwell filter

With or without automatic operators . . . and despite a heavy concentration of grit in the slurry . . . . DeZurik Plug Valves shut off tight! And they open easily — without lubrication!

They're the *only* plug valves with resilient-faced plugs and eccentric action! In DeZurik Valves, the plug is pivoted eccentrically — backing away from the seat with the first fractional opening movement. There is no friction between the plug and the body; no sticking or jamming — no need for lubricants — just an easy quarter-turn from wide open to dead shut!

Closing the valve presses the resilient-faced plug against the seat — sealing *around* sand or grit lodged on the seat.

(DeZurik Valves have an effective life three-to-four times that of ordinary valves on a service which requires 100% seal *with 25-to-60% sand in the slurry!*)

Resilient plug facings also resist abrasion from solids in the flow, delivering longer life with less maintenance.

Get more information on DeZurik Plug Valves. Representatives are in all principal cities; or write to

DeZURIK CORPORATION
SARTELL, MINNESOTA

see what MARCY can do for YOU!

they just keep rollin' along

It's not unusual for Marcy Mills to put in 98% or 99% of total time in productive operation, month after month, year after year. That's because Mine and Smelter's 40 years of specialized experience in the design and manufacture of grinding mills has resulted in a selection of materials and type of construction which stand up under the most severe, continuous service.

COMPARE THESE IMPORTANT MARCY MILL CONSTRUCTION FEATURES...

Removable, special bronze alloy bushing will not scour, is easy to replace.

Heavy bearing sole plates dampen vibration and shock load to concrete foundation.

Self-aligning ball and socket trunnion bearings.

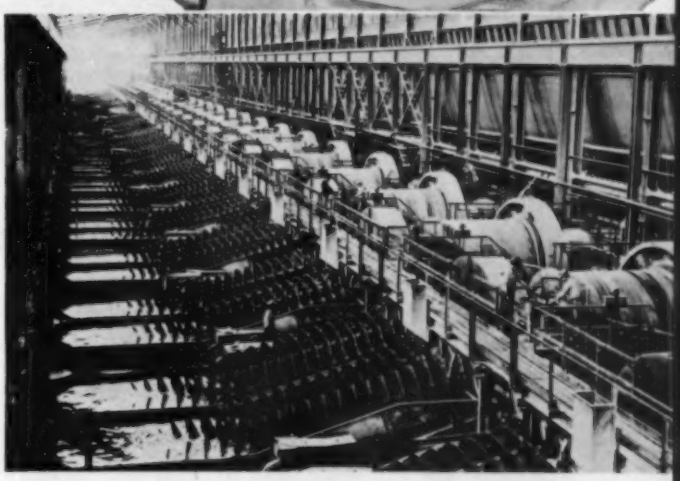
Meehanite Metal heads...Meehanite's uniform density, high tensile strength, fatigue strength, rigidity and impact strength provide qualities of toughness and resilience.

Heads are separate from shell...if a trunnion is damaged you do not have to replace entire mill. Trunnions can be furnished separate from heads.

Male and female fits on flanges take shear off of bolts and assure proper alignment.

Heavy plate steel shell.

Gears have cut teeth, are split and reversible.



Typical installation of Marcy Mills in a large copper mill, where big tonnage, continuous operation are essential to profitable milling.

NO EXTRA CHARGE FOR MARCY® EXPERIENCE

THE MINE AND SMELTER SUPPLY CO.

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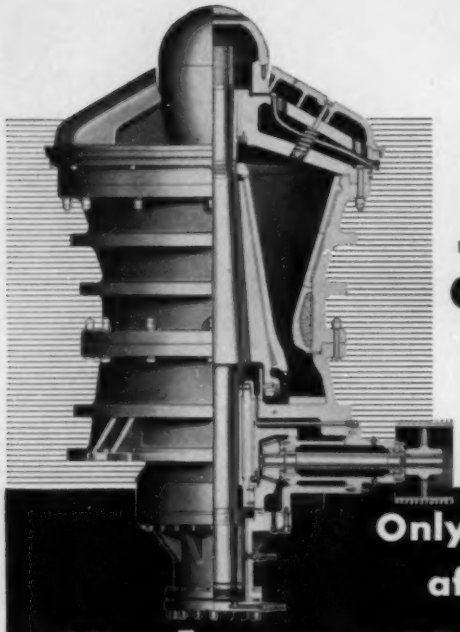
SALES AGENTS AND LICENSED MANUFACTURERS THROUGHOUT THE WORLD



Superior

Primary and Secondary

Crusher

Bulletin O7B7870

- *Retains initial setting* by compensating for wear on crushing surfaces with one-man, one-minute *Hydroset* mechanism.
- *Entire circuit remains in balance.* Feed size to subsequent equipment remains uniform.
- *Aid in starting* is provided after crusher stops under load. *Hydroset* control reduces torque requirements. Clearing of the crushing chamber is facilitated.
- *High capacity* is the result of a unique crushing chamber design and *Hydroset* control of mainshaft position.

Only Allis-Chalmers gyratory crushers afford the many advantages of

Hydroset Mechanism

Hydrocone

Secondary and Tertiary

Crusher

Bulletin O7B7145C

- *Wide range of settings* at the flip of a switch is made possible by the *Hydroset* mechanism.
- *Chamber is cleared* — if crusher stops under load — by merely lowering the mainshaft hydraulically with the *Hydroset* mechanism.
- *Protection against tramp iron* is provided by *Hydroset* mechanism and Automatic Reset. After tramp iron is released, crusher returns to original setting. Safe — no spring-loaded chamber.
- *Compensation for wear,* as in the primary crusher, is a one-man, one-minute operation with *Hydroset* control.

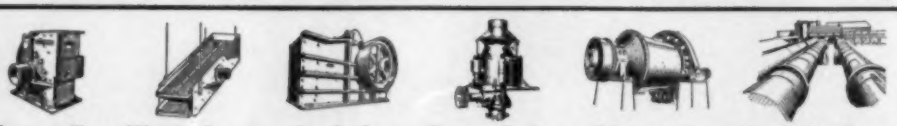
Proved all over the world —

Limestone in China, iron ore in Africa, lead zinc in South America—gravel, dolomite, cement clinker, copper, perlite, trap rock — name the product, name the location, you'll find the *Hydroset* mechanism on the job proving its tremendous profit advantage. Hundreds of Allis-Chalmers gyratory crushers, processing the widest range of products, are equipped with *Hydroset* mechanism. Even the world's largest crusher, crushing hard taconite, features the convenience and economy of this remarkable design feature.

See your Allis-Chalmers representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

Superior, Hydrocone and Hydroset are Allis-Chalmers trademarks.

ALLIS-CHALMERS



Hammermills | Vibrating Screens | Jaw Crushers | Gyratory Crushers | Grinding Mills | Kilns, Coolers, Dryers

A-5322

Engineering Societies Library

SOON after the AIME was founded it began to collect books at its headquarters. This was also true of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, who later combined their libraries with that of AIME to form the Engineering Societies Library. None of these collections in their early days could truly be called libraries, for they were largely unindexed and uncatalogued; yet even so, the collections were useful and the Societies were proud of them. A history of one of the Societies reports several moves in its early years to acquire more space for its staff and library. One move is recorded as being particularly satisfying, for the premises had improved gas lighting where its members could read at night!

About the turn of the century there was much discussion of a union home for the engineering societies but, despite the discussions, little was done for many years. In 1903, Schuyler Skaats Wheeler, a member of the AIEE, became the possessor of a remarkable collection of electrical books which had belonged to Latimer Clark, an English engineer. Mr. Wheeler said, in presenting the collection to the AIEE, that it was his intention to make it the custodian of the most complete electrical library in the world as well as to stimulate such interest that the Institute might in time own a permanent home in New York. This fine collection of electrical books, and the libraries of the other Founder Engineering Societies were called to the attention of Andrew Carnegie and undoubtedly they were important factors in arousing his interest and help in securing the present building.

How It Began and Grew

In 1907, three of the present Founder Engineering Societies moved their offices into the building at 29 W. 39th St. and placed their separate collections of books adjacent to each other in the reading room on the 13th floor of the building. By 1913 the three Societies agreed to merge their libraries under the direction of a trained librarian and a single library board. A few years later the ASChE moved into the building and its library became a part of the Engineering Societies Library.

The Engineering Societies Library, the library of the Four Founder Societies, is a department of the United Engineering Trustees Inc. The Library Board is composed of representatives of the Four Founder Societies and of UET. Prior to merging the libraries, some of the Societies were spending well over $1 per member annually for library operations, not including light or heat. Since the libraries have been combined, the cost is about one half of this. The Four Founder Societies' contribution to the Library amounts to about $80,000 this year. Income from services rendered by the Library is nearly $50,000.

Library Contents

The relatively unorganized separate collections of more than 40 years ago have been combined, organized, and catalogued. Duplication has been eliminated and much material received years ago as gifts, but of little value to engineers, has been discarded. Through the direction of the Founder Societies' members who have served on the Library Board, and through the work of many staff members, the Engineering Societies Library has become outstanding in the fields of the Founder Societies—civil, electrical, mechanical, mining, metallurgical, and petroleum engineering. The Library contains some 173,000 volumes covering all branches of engineering, primarily on the level of graduate and practicing engineers. Over 1400 periodicals are currently received from all parts of the world.

Through cooperation with the Engineering Index, important engineering books and articles in periodicals received by the Library are indexed in the daily card service and annual volumes of the Engineering Index. Through this—the world's most extensive published index to engineering literature—engineers have a key to the excellent collection of the Engineering Societies Library.

Library Services

The Engineering Societies Library has developed services that make it useful to those who cannot visit the Library as well as to those who can. Its staff prepares reviews of hundreds of important engineering books each year. These reviews, published in the journals of the Founder Societies and of other organizations, make it easy for engineers to learn about new engineering books of interest to them. These and other books in the Engineering Societies Library may be borrowed by members of the Founder Societies in the U. S. and Canada. Each year thousands of engineers and organizations use the Library's literature searching and translation services and its photoprint and microfilm copying services that are available to anyone anywhere without membership restriction. Other thousands use the public reading room of the Library.

Visitors to the reading room reached an all time high during the depression years of the 1930's, but since then the number of those served outside the Library has continually increased and such service now exceeds visitor use of the Engineering Societies Library. This is a desirable trend, as it widens the usefulness of the Library; however, it adds greatly to the work of the Library, for a request answered by mail takes much more time than one answered in the reading room where the inquirer usually does most of the work of finding the information wanted.

The Library Today

The Engineering Societies Library is a busy information center. Last year 75,000 photoprints were made and sent to engineers everywhere. Microfilm is particularly favored by those in foreign countries who order copies of material in this Library. Hundreds of thousands of words have been translated from a dozen different languages into English in each recent year.

Literature searches made on specific order help engineers improve the products of industry. They enable researchers to start from where previous work has stopped, and in many other ways save the time and expense of engineering work. All literature search work is kept confidential. In addition, the Library prepares bibliographies which are of general interest and are available for purchase by anyone.

A free information folder about the Library and its services, and a list of available bibliographies can be had by writing or calling the Engineering Societies Library, 29 W. 39th St., New York 18, N. Y.

—Ralph H. Phelps

ANNOUNCEMENT! The new, improved

No. 933 (Series E) TRAXCAVATOR*

is ready

with longer life, lower maintenance!

Looks a lot like the popular No. 933 you already know—but there's greater stability, performance and durability built into this new Series E!

Now the rugged CAT* No. 933 Traxcavator includes a new heavy-duty undercarriage with:

- New Rugged Track Roller Frame
- New Solid Sprockets
- New Heavier Idlers
- New Tough Track Rollers

The complete line of Cat-built Traxcavators	No. 977	No. 955	New No. 933 (Series E)
Flywheel HP at sea level	100	70	50
Bucket capacity, cu. yd.	2¼	1½	1
Bucket tip-back at ground level	40°	40°	40°
Bucket tip-back at maximum lift	46½°	47½°	48°
Dumping height (center of hinge pin to ground)	141½"	128"	119 3/8"

The easy operation, the great capacity and the dependable power—these features remain as outstanding as before.

For complete details on this *tough* new Traxcavator, call your Caterpillar Dealer. He'll be glad to give you full information on the complete line of Cat-built Traxcavators. He's the man to remember, too, for expert service and for replacement parts you can trust.

Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

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ONE GOAL: To concentrate our capabilities, resources and experience on the design, manufacture, distribution and service of job-tested heavy equipment.

Foreign Private Investment — A Boon to Developing Countries

The country encouraging the private investor will reap incalculable rewards in terms of employment, better living standards, and improved national income, capability and security.

by Evan Just

THE high standards of living and improved national security that industrialization can bring are so evident that no country can be named that does not cherish the hope of industrializing. With such a universal aim, why do many countries unable to develop their own industries accomplish so little toward attracting the foreign private investor, who alone can provide them with the necessary capital and skill? Obviously, because they fail to understand what constitutes a favorable climate for investment, because they have false notions about being exploited or dominated by the foreign investor, or because they are so nationalistic they refuse to permit outside assistance.

The purpose of this paper is to aid the citizens and policy makers of developing countries in achieving their aims, by defining the conditions which encourage investment and portraying the results of a policy of encouragement. The following is quoted from Eugene R. Black, president of the World Bank:

> The danger today is not that the foreign investor will ask too much of a developing country, but that the developing countries will do too little to attract him. Today the foreign investor cannot go into a country unless he is actually wanted by the people of the country. By indulging the myth that the private investor is trying to force an entry to engage in some sort of evil exploitation, the less developed countries are cutting themselves off from one of the most productive sources of development assistance available to them. The capital and skills which the private investor brings with him may not be available from anyone else. Particularly, he brings with him the skills of industrial management—skills which have to be seen in action to be learned. If a country is bent on industrializing and having the benefits spread broadly among the people, it can do itself no better service than to seek out the private investor abroad who is willing to risk his capital on the chance of a fair return on a successful venture.

The representative of a developing country should consider first what choices are available to him. His country can, of course, discourage industrialization, and suffer the consequences in low living standards, national insecurity, and expensive imports. It can send its young men to foreign schools or seek technical assistance from foreign governments, but it is evident that such policies by themselves are frustrating and ineffective. In addition to basic requirements of raw materials and energetic labor, efficient industrial production is the result of a complex aggregation of capital, management, technology, skill, and incentives; all are necessary and in proper balance. Experience has shown that the private investor can provide them. Therefore, the only basis for not encouraging him is either nationalistic self-indulgence or fear that he will become a disruptive or destructive influence.

Probably the best answer to this fear lies in experience. The most highly industrialized countries have always been open to foreign investment and there is no evidence that they regret it or that they wish to change their open door policies. Paradoxically, nations that need outside help the least have the most effective policies of encouragement. Rapidly developing countries like Canada, Peru, South Africa, Australia, and Venezuela, which have encouraged foreign investment, find their prosperity, strength, and economic growth so much improved that they wish more, not less of the foreign investor. It may be pointed out that in recent months concern has been voiced in Canada over the ratio of foreign to domestic investment. However, it would be misinterpretation to state that Canada regrets its open door policy. Most Canadians recognize the immense benefits they have enjoyed from investment of foreign capital.

No country that has permitted or encouraged the American private mineral investor has found him to be a cause of political instability. In fact, the economic growth he fosters improves political stability. In general, American industrialists have neither aptitude nor appetite for political affairs. In those rare cases where they have meddled in foreign political matters, their motives have been to protect investments, not a positive desire to exercise political influence. Their essential interests are in profits and reinvestment opportunities. Given reasonable politi-

E. JUST is Vice President of Cyprus Mines Corp.

Morococha Mine of Cerro de Pasco, Peru. This property is part of a complex of plants of various types which are working every day to produce more wealth for Peru.

cal stability, they would prefer to avoid political activity.

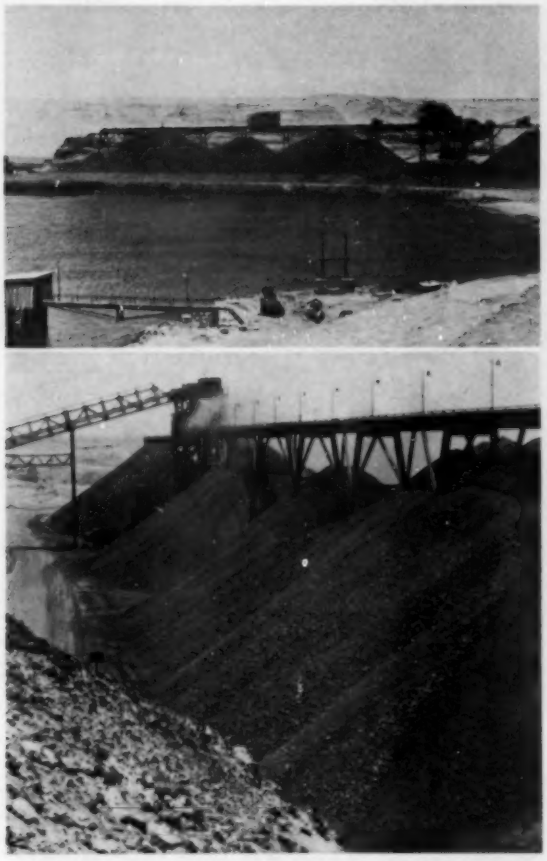
The position is also taken, or at least inferred, that the withdrawal of profits constitutes exploitation or economic drainage. The falsity of such an attitude is easily demonstrated. First, this position ignores many benefits which are corollary to mineral enterprise but which far outweigh profits. These include better wages for workers; additions to national income; improved national self-sufficiency; modern nutrition; training for workers; training for supervisory administrative, and technical personnel; improved housing, schooling, and medical attention; and support for desirable facilities such as power, roads, and railroads. Second, the following table shows specifically how small profits withdrawals are in comparison to the total benefits produced by mineral enterprises. All of these are typical examples, the first two of mining, the third of petroleum. In all cases the figures are percentages:

Item	A, Pct	B, Pct	C, Pct
Gross receipts	100	100	100
Operating expenses	68	33	26
Paid to government	10	28	33
Reinvested current earnings	13	—	5
Retained in treasury	6	23	7
Dividends	3	16	29
Percentage of total expenditures retained within country	87	64	61

Naturally, any country would prefer to have profits reinvested rather than exported. However, investment being a voluntary act, experience has demonstrated that the greatest reinvestment will occur where the least compulsion is applied. In fact, compulsions are almost certain to dry up interest in making new investments.

The above reasoning may not appeal to those who prefer to deny their country the benefits of investment because of nationalistic zeal. To those who prefer to shelter a few of their own investors from competition at public expense, or who choose to foment extreme nationalism in order to win political acclaim, little can be said. But to those who incline toward government rather than private finance, it is possible to say, "Point out the place where government is doing a good industrial job." To a certain extent, government finance of basic facilities like power and transportation can be helpful. But all human experience, past and present, proves that government cannot conduct an industrial job well, as the communist experiments are so vividly demonstrating.

With regard to the field of mineral resources, there are also nationalists who, viewing minerals as depletable, wish to conserve them entirely for their own people. To them it can be pointed out that unavailable minerals in the ground are no asset to anybody. By an isolationist attitude, how long will they delay their own national development and what risks do they take in keeping their countries unnecessarily weak? Moreover, if they entertain the



Modern stockpile and loading dock of Marcona Mining Co., Peru, has transformed an undeveloped cove into a thriving port.

view that at some long time hence they can profit by being rich in resources while others are poor, do they believe that world morality at that time will protect their position? Also, do they reckon with the potency of atomic energy as a means of making man able to build the future of civilization on a foundation of common materials? These are questions, not answers, but it cannot be denied that the nationalist who retards his country's development is taking a serious risk with its future security. A realistic patriot is likely to pin his faith on making his people more capable, healthy, and educated, and his industries strong, particularly when he knows that the foreign investor has no reluctance to train local people, treat employes well, face domestic competition, accommodate local participation, and refrain from political activity. Actually, the whole theory of nationalistic exclusion of the private investor falls apart when the benefits of his activity are properly weighed, when his attitude and aims are correctly understood, and when it is realized that he is at all times subect to the laws of the country he enters.

It is readily understood that a country will be strongest when its industries are diversified, both geographically and in kind. Nevertheless, mineral industries are particularly important to a developing country. They fit in most easily with the development of essential transportation and power facilities, being largely dependent on both. They are commonly located where other industries do not readily go. They furnish either foreign exchange or raw materials required in construction and manufacturing, and they train people in a variety of important skills. No logical program of industrial expansion can be conducted without including development of a country's mineral resources. In some developing countries, the mineral industry provides more than half of industrial wages, tax revenues, and foreign exchange.

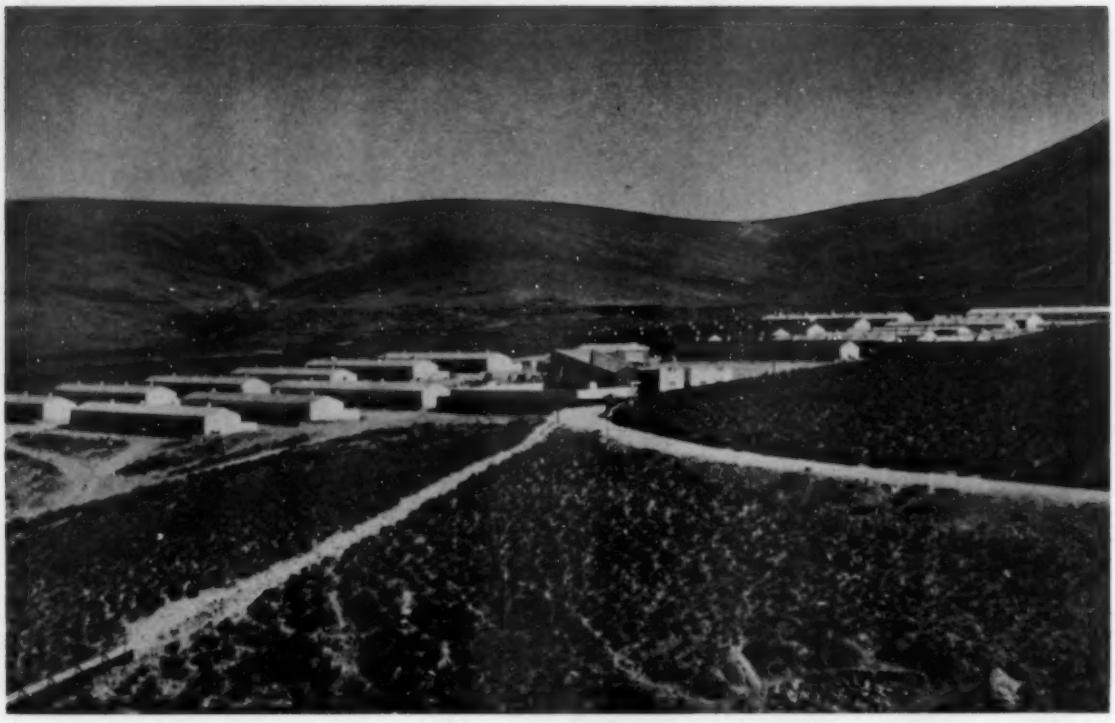
For those countries that wish the benefits of private investment, the following conditions are essential to a climate of encouragement:

Opportunity to earn profit. This is axiomatic, profit being the purpose for which investments are made.

The right to control the operation that the investment generates. This is often a troublesome point, as developing countries are likely to fear that their sovereignty may be impaired if they fail to require that an ownership majority or a directorship majority should be of their own citizens. It is enough to require that the operating organization be located in the country of operation and subject to its laws. A sovereign state is always able to protect itself and its people against domination, by normal tax and regulatory means, and the requirements for control by its own citizens are superfluous. No sensible investor is willing to lose control of his property, and such requirements simply lead to evasions, such as the setting up of proxy boards, or refusal to invest. Moreover, many investors will, without compulsions, find it good business to have local citizens associated with their enterprises.

If a developing country wishes to be assured that its citizens can participate in a new enterprise after a reasonable time, acceptable steps can be taken to these ends. In many cases, no specific steps are necessary, as shares in the enterprise or the one controlling it will be found listed on stock exchanges. If not, many American investors will be willing to allow participation and welcome it, on a postponed basis if not immediately. It is well to realize that the private investor is usually most deeply concerned with recovery of his principal and a profit adequate to justify the effort and risk; thus, if immediate shareholding is not feasible, some arrangement for deferred participation will often be negotiable. If such a course is taken, it would be wise to proceed cautiously, as a lessened interest on the part of foreign owners might deprive an operation of indispensable factors, such as excellent management, desirable market outlets, or attractive transportation facilities. Also, in many countries, their own citizens who are financially able to invest in industrial enterprises do not choose to do so, preferring real estate or foreign enterprises. The private investor cannot compel them to join him in building up local industries.

The right to sell the product in free markets of the investor's own choosing. Nothing is more depressing to an investor's spirit than an expectation that he will be forced to sell in a regulated or restricted market. He is accustomed to the rigors of free markets and is willing to take his chances with them. From his viewpoint, such risks are considered calculable, and if his calculations err, he has roughly as much chance of errors being in his favor as adverse. He views a restricted market as one almost certain to reduce or eliminate profit, with no com-



Aguilar property of St. Joseph Lead Co. Argentina. This modern camp of Compania Mineria Aguilar represents the best living and sanitation its occupants have ever experienced.

pensating advantages. Also, the right to sell in markets of his own choice gives him a chance to acquire the more desirable and useful types of currency. Usually he will be entirely willing to serve any domestic market for his product as long as the conditions are reasonable. He always has a large requirement for local currency to cover wages, taxes, and local supplies, and a domestic market will usually save him part of a large transportation cost.

The right to bring home profits and amortization funds in either the currency invested or that generated by sale of the product. Even though, circumstances being favorable, the investor is likely to reinvest his profits in the developing country, he usually does not regard an investment as recouped or a profit as real until it is brought home, and he is disinclined to invest in an area where these funds are likely to be impounded or only exportable at a disadvantage.

To maintain a proper perspective on this problem, the developing country should bear in mind that profits and amortization funds are bound to be only a small fraction of the total foreign exchange made available by most mineral enterprises.

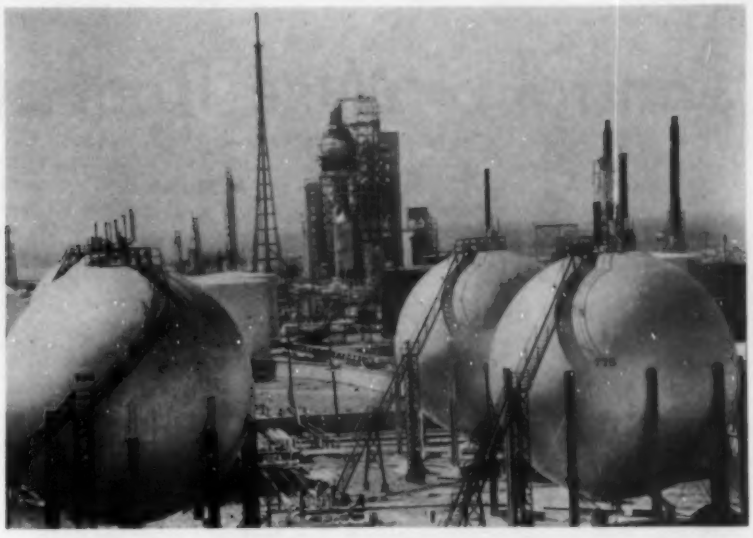
Freedom from burdensome taxation. The reluctance of an investor to face burdensome taxation is sufficiently understandable to require no explanation. However, it may be helpful to remark that taxes are most bearable when applied in a form that makes them deductible from taxes paid in the investor's home country. Under the heavy tax rates current today, taxes become intolerable if they apply separately to the same income. A reasonable tax applied as income tax can be relatively painless to the American investor, because he would have to pay a large share of it at home if not in the country where the income is earned, provided that the country concerned has a reciprocal tax agreement with the U. S. Government. On the other hand, the same amount applied as royalty or an *ad valorem*, severance, or export levy could well eliminate the incentive to do business. The taxes levied in one mining country today not only accomplish this undersirable end, but also unnecessarily hamper the competitive strength of its producers and foster a wasteful type of operation that will be regretted in the future.

In a businesslike exploration for minerals, the investor takes a gambler's risk against natural conditions and knows that most new ventures will be failures. To assume such risks becomes illogical if local tax policies prevent realizing a gambler's reward when the occasional victory is achieved against natural obstacles.

Freedom from artificial impediments to trade, such as exchange controls, price controls, and export-import controls. The investor is likely to believe that the hazards of doing business are enough, without facing arbitrarily applied difficulties that always operate to his disadvantage. Also, except for temporary emergency purposes, experience has demonstrated that such controls tend to produce economic stagnation and results opposite from those sought.

Freedom from import duties on capital goods and necessary supplies not produced in the country. The investor's position is that his efforts to create new income, employment, and self-sufficiency should not be impaired by customs duties that are frequently not only burdensome but illogical. Such imposts in effect levy a tax against potential income before income is produced.

Nondiscriminatory treatment under law. The investor naturally expects to enjoy an equal position under law and to have his rights defined by law



Such complex and expensive installations as at this refinery of Lago Oil and Transport Co. in Aruba, and the skill to run them, can be obtained only from overseas investors.

rather than by decree. He fears rule by decree as being unpredictable and changeable and as placing him at the mercy of a few people.

Reasonable political stability. Even though many countries have gone through several revolutions without disturbing foreign investors seriously, the prospect of civil disorder or revolution is a great deterrent to investment. Uncertainty breeds as much fear as adverse conditions, and the foreign investor usually shuns areas where the possibility of coming under the control of irresponsible, violent, or inexperienced persons looms up in his mind. It is a poor answer to say that investment does, nevertheless, go on in politically unstable areas. The flow of investment would be much greater to these areas if political conditions were more predictable and attractive.

Now to discuss some of the points that usually affect policy in developing countries:

Employment of local citizens. This is generally recognized as a reasonable and acceptable aim, toward which the foreign investor is usually willing to cooperate as long as requirements do not prevent an efficient operation. In most cases he would do so voluntarily—he wants the most easily available labor supply. In a new operation he will want to fill key positions with people of proved capability, but it is only good business to fill nearly all positions with local citizens as rapidly as individuals of proper capability can be found or trained. No other policy makes sense, as bringing in outsiders involves problems of added cost, turnover, compatibility, and public relations.

Paternalism. The American investor respects the right of other countries to determine the level of social security they wish to have. Nevertheless, certain remarks on such policies can be presented as simple common sense. First, an extensive program of worker and social benefits cannot be meaningful without a sound financial base, and no such base will be provided if the program is so costly that it simply induces the entrepreneur and investor to go elsewhere. Second, no such program can be a success unless both workers and government realize that social security is not a natural human right but a reward for productivity, loyalty, and operating efficiency. Any concept that social security can be successfully provided to the exclusion of profits attractive enough to encourage investment and reinvestment is nonsense and demonstrates nothing but lack of experience. Any attempt to reward slothful, disloyal, or inefficient people can only do harm to the constructive members of society in much greater proportion than benefits are reaped by the undeserving. Industry is not a cornucopia from which wealth flows spontaneously. Wealth is the product of work, resources, ingenuity, loyalty, investment, management, and skill. In a dynamic society all these elements must be recognized. When they are, the benefits can be amazingly large.

Tax incentives. Some progressive countries, conscious that the investor is actually interested in recoupment of his principal, have granted temporary tax exemptions, special treatment of capital gains, and percentage depletion as incentives. There have been notable successes in the rate at which percentage depletion has stimulated investment in oil and gas development in the U. S. and in the number of new mining ventures induced by Canadian tax privileges. Without attempting to justify any of these measures on theoretical grounds, it is apparent that investment incentives are worthwhile in terms of results produced. These results merit particular study by countries operating under the reverse theory of taxing the mineral industry more heavily than other industries.

The country that encourages the private investor will reap incalculable rewards in terms of employment, better living standards, and improved national income, capability, and security. It can be predicted that those that do so will want him more and more, not less and less, as their prosperity and self-sufficiency improves. A fountain of free wealth would hardly compare in fruitfulness with the fantastic productivity of an industrial system that rewards labor, capital, enterprise, and skill adequately. Capital has discovered that wealth shared with productive labor and skill comes back tenfold. Labor is learning that good management and a high rate of reinvestment are its own best guarantee of better living and a more secure future. With all its spectacular industrial achievements, the U. S. is only beginning to learn of the bounty that springs from mutual helpfulness between men.

Control of Mine Roof at Oakfield

Though costly in its initial stages, roof bolting has proved a saving addition to mine operation.

by Edward Ernst and Richard Runvik

AT the U. S. Gypsum Co. mine in Oakfield, N. Y., a flat-lying vein of rock gypsum is mined by the room and pillar method. Averaging only 4 ft thick, this vein is 1200 to 6000 ft in mineable width and many miles in length. Overlying the vein throughout the mine is a 2-ft thickness of distintegrated gypseous shale and fractured limestone which parts easily, falling with little or no warning.

This shale, known as *ash*, varies in thickness from less than an inch to more than a foot. Small veinlets of selenite cut this shaley material, which breaks around timber props. The 18-in. limestone overlying the ash is fractured vertically into blocks of varying size and will fail if any but the shortest unsupported spans are permitted. Above these two members is a thick layer of competent limestone.

With the advent of mechanized loading methods and trackless haulage, wider areas were needed for equipment. This meant wider spans of unsupported roof, which could not be safely obtained while timber props were used for roof support. Props had to be reset at mining faces after every blast, a dangerous procedure, since the roof was alternately tight (propped) and loose (not propped).

Experience has shown, particularly in coal mines, that bolts have a dual purpose. Actual support is attained with roof bolts, but formation of a *beam* effect is more important. Roof strata are held together tightly by the bolts, and pillars at each end of the *beam* support most of the weight. Since it is important that lamination of the roof strata be kept tight, roof bolting is required as soon as the underlying gypsum is removed.

Experimental roof bolting was inaugurated at Oakfield with a hydraulic lift jack and an electric drill held by two men. Drilling was done with auger-type steel and wedge-shaped carbide insert bits. During the test period bolts were successfully installed at random in areas of especially bad roof, and then only in conjunction with timber props.

This arrangement was tedious and the equipment too light for effective general use. Better results were obtained with a heavier, more mobile roof bolting machine, electrically powered and operated by one man. The same drill steel and bits were used as before, but bolts were now located on 4-ft centers, with a line of timber props set 5 ft out from each side of the 22-ft wide rooms. A second machine of this type was put into service in the hope that complete bolting could be achieved on the mechanized, trackless haulage sections. After a year of operation and testing, drilling time of these two units was found adversely slow—the machines were too cumbersome to allow operators to keep pace with the loading crew.

Actual support by roof bolting had been successful, and the program was continued. A self-tramming, electrically powered, hydraulically operated roof control drill was placed in one of the mechanical loader sections. Of greater weight and power than the mobile drill, easily operated, and maneuverable under low roof, this machine installed bolts at high speed and with low maintenance costs, employing the same type of bits and drill steel used in prior testing. A dust collector functioned as an integral part of the drill, eliminating any possibility of respiratory disorders. At first, bolts were installed on the pre-set pattern of 4-ft centers and in conjunction with timber props, but later this spacing was increased to 5 ft. A second unit proved as successful as the first, and exhaustive testing of both techniques and the units themselves proved that the major roof control problem had been solved. Two additional machines were acquired in 1953.

Up to this time only the fractured limestone roof rock had been bolted, the overlying competent limestone being used for anchorage. The soft, usually water-bearing ash underlying the fractured limestone either fell of its own weight or had to be barred down by hand. An attempt was now made to bolt the ash and fractured limestone without impairing the excellent results so far obtained. It was found that if roof bolting followed immediately after the shot was cleaned from a room, the ash could be bolted successfully in all areas.

Timber Support Eliminated: In rooms where they had been set in conjunction with roof bolts, timber props were shot away. Other rooms were newly bolted and no timber set. It was found that under these conditions safe operation was possible, and since January 1954 mechanized loading sections of

E. ERNST is Mine Superintendent and R. RUNVIK Mining Engineer at the Oakfield, N. Y., mine of U. S. Gypsum Co.

the mine have been completely roof bolted, without timber supports. Following directly behind loading machines, a roof control unit bolts a newly cleaned room before the next round of drilling and blasting. In each section a second machine stands by in case of breakdown or other delay.

Twenty-five percent of daily mine production at Oakfield is accounted for by scraper-loader machines, which operate under low roof or in small reserve blocks where trackless haulage would be difficult or uneconomical.

Roof conditions at these slushers are identical to those in other areas of the mine, and it was believed that the excellent results from roof bolting in the mechanized loading sections could be duplicated, at least in part, on the scraper-loader sections. A mobile roof bolt drill used in earlier testing proved satisfactory in the slusher, since only a few bolt installations were required per shift. Testing followed the former procedure—only the fractured limestone was bolted, and timber props were used in addition. Later the ash was bolted and the props were removed. Roof control factors were found to be very good, and since January 1955 the scraper-loader units have been completely roof bolted by mobile drills of the type used in testing.

Roof Bolt Type and Pattern Used: Supplied by Bethlehem Steel Co., Lebanon, Pa., at $0.845 per unit delivered at Oakfield, the complete roof bolt unit now used consists of a 36-in. long, ¾-in. diam mild steel bolt, an expansion shield and plug, a lock washer as needed and a ⅜-in. steel plate 6 in. square. The bolt is threaded up to 3½ in. and has two cold pressed ears 29/32 of in. diam at the beginning of the thread. The lock washer is used in badly cracked or wet roof and is threaded down the bolt to the pressed ears. This prevents the expansion shield from traveling down the bolt in the event of slippage when the bolt is installed.

Installed on 5-ft centers, bolts are set at 2½ ft and 7½ ft on each side of the center line of the rooms. Crosscuts between rooms are bolted the same way, and additional bolts are inserted on closer centers where warranted by roof conditions. Minimum protrusion below the roof line is achieved by using the ⅜-in. plate and bolts with a 1⅛-sq in. x ⅝-in. flat top head.

Testing Bolts for Safety: All roof bolts are installed at more than 175 ft per lb of torque and checked with a hand wrench at the time of installation. Once each week every foreman spot-checks bolts in the working areas with a torque wrench. A permanent record of these inspections is kept by the mine superintendent. Any bolt found to give a reading of less than 175 ft per lb of torque is tightened up to that reading and rechecked on succeeding shifts. Loose and protruding bolts are replaced immediately.

It is assumed for these purposes that installed torque is proportional to the installed tension. Recognizing that tension, rather than torque, determines effectiveness, Bethlehem Steel Co. sends representatives who make periodic anchorage tests, gaging the hole and determining both applied torque and the pounds necessary to cause expansion shields to slip.

The ¾-in. mild steel roof bolts will break at 22,000 lb, or 11 tons. Since bolts are installed on 5-ft centers, the maximum area supported by any single bolt is 25 sq. ft. Average roof thickness supported is 18 in., and the rock weighs about 150 lb per cu ft. Therefore the total average load possible on any roof bolt is

$$\frac{25 \text{ x } 1.5 \text{ x } 150 \text{ lb per cu ft}}{2000 \text{ lb}} = 2.8 \text{ tons.}$$

A maximum condition would be 2 ft of roof, or

$$\frac{25 \text{ x } 2.0 \text{ x } 150 \text{ lb per cu ft}}{2000 \text{ lb}} = 3.75 \text{ tons}$$

Thus an average safety factor is

$$\frac{11 \text{ tons x } 100}{2.8 \text{ tons}} = 390 \text{ pct}$$

and a minimum safety factor is

$$\frac{11 \text{ tons x } 100}{3.75 \text{ tons}} = 290 \text{ pct}$$

The excellent safety factor no doubt explains why there has been no failure of bolted roof at the Oakfield mine since the first seemingly inadequate installations in 1951.

Roof Bolting Equipment: After nearly five years, the J. H. Fletcher rotary roof control drills are capable of maintaining a good installation rate. The one man required to operate each machine can install 40 bolts per 7-hr shift. As many as five bolts have been placed per 7-hr shift, but this is the exception.

Each of the slusher-type loading units is assigned a Chicago-Pneumatic RBD rotary roof drill with screw-lift feed. A spare drill stands by at all times. Manually tramming and electrically powered, each C-P machine is operated by the faceman, or loader helper, of the scraper crew whenever he is not actually on production. Since daily tonnage from each of the slushers is relatively small, an average of ten bolts per shift is maintained for the C-P drills.

Each year about 55,000 roof bolts are installed at Oakfield. More than 200,000 have been installed since the beginning of roof bolt testing.

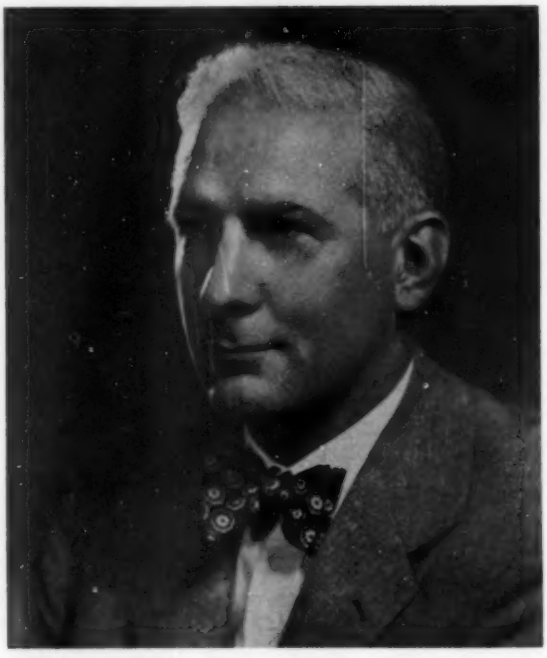
Drill steel for roof bolting is purchased in 18-in. and 36-in. lengths from the mining tool division of Kennametal Inc. at Bedford, Pa. All drill steel is of auger-type AF-13, with 1⅛-in. square shanks and ½-in. square chucks. Life of these steels is good, but many vary according to the proficiency of the drill operator.

Bit Life: Wedge-shaped Kennametal tungsten carbide bits, grade FDH, are currently used on all bolting units. Starter bits are 1½ in.; 1⅜-in. bits are used to finish holes. Average life throughout the mine is 170 ft per bit. The Fletcher roof control drills average 250 ft per bit and the Chicago-Pneumatic machines 80 ft per bit. Average bit price is $4.25 each in lots of 500 or more. A cost of $0.075 for bit usage can be added to the $0.845 for the bolt unit.

Advantages of Roof Bolting: As compared to former practice at Oakfield, there are many advantages to complete roof bolting. The primary safety objective of the program has clearly been attained in the elimination of lost time roof fall accidents and in the improved morale of operating personnel. Efficiency has increased; hence operating costs have improved. Since mine-run gypsum is no longer contaminated by excess roof falls, quality of rock supplied to the mill has improved several percent. Housekeeping throughout the mine has improved immeasurably, and recovery of reserve rock has increased. Production delays due to moving fallen rock have decreased from 58 pct of total delay time in 1951 to only 10 pct in 1956.

Robert H. Richards Award Recipient Discusses —

The Mineral Engineering Profession



A. M. Gaudin

(At an Annual Meeting session of the Minerals Beneficiation Division in New Orleans, A. M. Gaudin, 1957 recipient of the Richards Award, gave the following address:)

This year the American Institute of Mining, Metallurgical and Petroleum Engineers has chosen to give me its Robert H. Richards Award, a distinction which is widely regarded as the highest honor in the field of mineral engineering. I am deeply moved by this tribute, which suggests not only regard for my service to the profession but also the affectionate esteem of my fellow mineral engineers. You have made me happy at the prospect of the permanent association of my name with that of Robert Hallowell Richards and of the distinguished recipients of the award, Arthur Fay Taggart, Frank R. Milliken, John F. Myers, Edward William Englemann, C. Harry Benedict, Edward W. Davis and Arthur W. Fahrenwald. I wish to thank you all for an honor so generously bestowed.

Professor Richards is known to us all as a legendary figure, and we can read about him in the Richards Memorial Volume of our Transactions. Some of us have even had the good fortune of knowing him. I count myself among those lucky few. In its intangible attributes the Award recalls those things for which Professor Richards stood: for Science in Art, for thoroughness, for meticulous accuracy, for bold imaginativeness, most of all for professional integrity. Now, as in his day, these attributes are central to an engineer's creed. They are appropriately needed in a formulation of a definition of the mineral engineering profession.

The citation for this year's Award makes it clear that the award has been made specifically for the effort of a team devoted to the development of a process for extracting uranium from low grade ores. I like to place emphasis on the thought that the Award was made not so much to me personally as to the team with which it was my good fortune to

A. M. GAUDIN is Richards Professor of Mineral Engineering, Massachusetts Institute of Technology.

have been associated for many years. May I therefore not only express to you my own thanks for the Award but also those of the many associates without whose entire devotion and cooperation it would have been impossible for me to have justified your selection. I know that each of the many men and women who have worked with me will be heartened to know of the appreciation which their fellow mineral engineers have seen fit to extend to them.

As many of you know, my principal field of activity has been centered on the flotation process. Many of you know also that I have been interested in practically all of the unit operations which are generally included in the field of what is now called mineral dressing. What is giving me an opportunity to talk to you today about mineral engineering—and may I underscore the word *engineering*—is that the processes which our group finally settled on in the creation of the new uranium extracting industry do not use primarily flotation nor gravity concentration, nor magnetic separation, but are instead employing unit operations, until this time foreign to mineral dressing and extractive metallurgy. I refer particularly to *ion-exchange* removal of selected solutes from complex solutions, and to *solvent extraction*. If my associates had insisted on developing processes for uranium extraction along mineral dressing lines or by hydrometallurgy—using these words in the narrow and conventional senses—they would not have succeeded to the degree their unfettered minds allowed them to reach.

Perhaps I may be pardoned if I ask those members of the audience who are of my own generation to recall a feature of the horse-and-buggy age which I think may have a message for us. I recall that the last four-legged exponents of that era were provided with blinders designed to prevent their seeing sideways. This would keep them on the straight and narrow path, on the beam, so to speak. I suppose that in thus making the animal into a machine they were most effective. But none of us could expect leadership of a horse so protected from lateral perception: that horse needed a horseman.

You know that what I am trying to say is that the device of compartmentalization of engineering, which in the past has resulted in different areas of localized interest in our own Society as well as elsewhere, has guided people without preparing them to become leaders. That compartmentalization, in our own case, has outlived its utility, and it is high time that we give substance to a more coherent professional entity centered on the arts of separating constituents associated naturally or through the work of man in any mineral or metal product. The central objective of our activity is to *separate* the components that occur in more or less intimate mechanical or chemical association. This concept of separation is the cement that holds together mineral technologists, smeltermen, cyanide men, flotation operators, and those chemical engineers turned mineral engineers.

I recall the time when our present area of interest was discharged by the Milling Methods Committee. Another committee was interested in coal cleaning. Still another group was interested in processing industrial minerals. There was even a group dedicated specifically to the concentration of magnetites from the eastern part of the United States. We have made progress since the 1920's. We generally recognize that ore dressing is not a wide enough scope for our activities and that *minerals* which are not *ores* are within our purview. We hold joint meetings with those interested in the preparation of coal or in the processing of industrial minerals, or even with those of our kind who are more particularly concerned with hydrometallurgy or pyrometallurgy. In speaking of this expansion in our professional arena, you will note that I have reviewed quite a number of the labels that describe bits and parcels of a larger whole. Yet I have failed to use the word *engineering*. Least of all is this because I have designed it that way! Indeed I think the word *engineering* is the missing element in all of our labels. We are primarily engineers. We are members of one of the Founder Engineering Societies. We are interested in minerals, in processing them, in extracting from them the desirable components, in marketing the products. I submit that there is no other term than *mineral engineering* that describes appropriately the range of interest which ought to be ours.

Our difficulty has had its roots in our heritage. As mineral enterprises proliferated, particularly during the nineteenth century, the art of sorting high grade ore by hand gradually fell into desuetude, to be replaced by gravity concentration. This activity remained at the mine, distinctly as an adjunct to the mine, and not particularly related to metallurgical processing of the ore.

The lowering of the grade of ores, the increased size and complexity of mills, the acceptance of physico-chemical and of fully chemical processes as milling operations, the introduction of ore dressing processes in smelters and other processing plants has made the distinction between mineral dressing and extractive metallurgy wholly artificial.

The future will bring us still more difficult problems, leaner ores, more complex mineral intergrowths, demands for wider utilization of byproducts, more exacting product specifications. The challenge of this future will be met fully only if we insist on the obligation that is upon us as mineral engineers to use or plan to use such processes or combination of processes as offer maximal advantage regardless of whether or not they involve methods generally accepted in mineral dressing, in coal cleaning, in coking, in smelting, or in leaching. Acceptance of this obligation means that we each must equip ourselves with fluency in the various arts and sciences that can be utilized in separating associated components, even though we may favor one specialty or another.

A corollary of this conclusion, and one of particular significance in regard to the character of mineral engineering problems that will require solution in the future, is that more and more of our activities will be team activities. (It will be recalled that this year's Award is for teamwork in developing a process to extract uranium in low grade ores.) Teamwork will be required of specialists who have a broad area of common knowledge in the arts of separation—physical, physico-chemical, chemical, or even nuclear—and an appreciation of the compelling need for mutual understanding and cooperation.

The citation of the award graciously refers to my function as an educator. I would be remiss if I did not take this opportunity to say to you that acceptance of the thesis I am propounding here today—that we must think of ourselves as mineral engineers in the separation, transformation, and marketing of mineral and metal substances—is the only one that will open for each of us to its possible widths the doors of opportunity in our profession.

Factors to Consider in Vibrating Screen Installations

Changes in design should come first, not after the screen is installed.

by Ned Kuenhold

AN equipment manufacturer swallows a bitter pill when he sees his machinery improperly installed and not used to the full potential. This frequently happens with vibrating screens.

Screens can be classified according to the path of vibration imparted to the screen surface. On this basis there are: 1) vertical circle or modified circle throw, 2) horizontal circle or modified circle throw, 3) vertical linear reciprocation, 4) tilted linear reciprocation, and 5) horizontal linear reciprocation.

The most versatile vibration for medium to coarse sizing is generally conceded to be the vertical circle produced by an eccentric or unbalanced shaft, but other types of vibration may be more suitable for certain screening operations, particularly in the finer sizes.

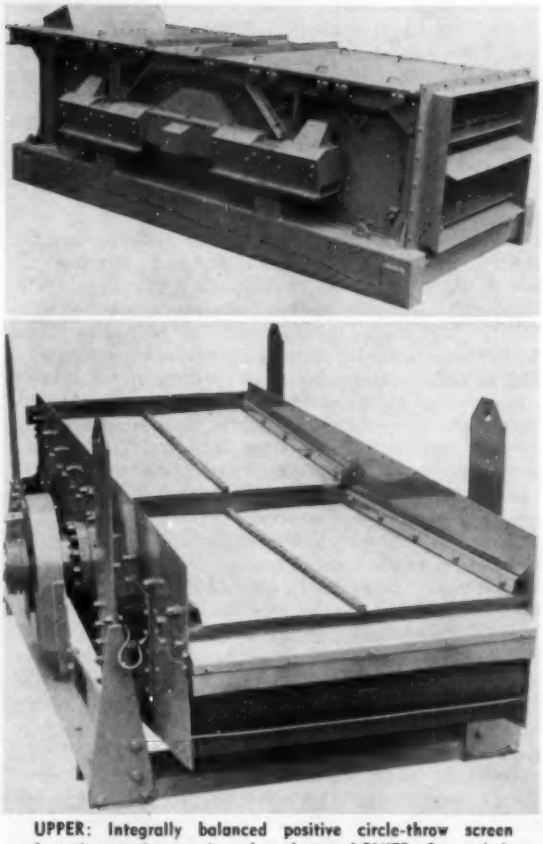
Vibrating screens are, in a sense, fatigue-testing mechanisms, and this service justifies the best design, materials, and workmanship. Many operators have learned that apparently inexpensive screens are too light for the job and result in costly down time, excessive maintenance, and eventual replacement.

Screen Size: Size of the selected screen is almost always determined by capacity requirements, although available space, headroom, and position of related handling equipment must be considered.

There is no single formula or chart to establish screen capacities, as too many variables affect performance. Screen consultants have to admit that they depend largely on previous experience, for which there is yet no substitute.

A basic factor to bear in mind is that screen capacity decreases with increasing amounts of oversize. A screen can handle considerably more feed containing only 10 pct coarser than the point of

N. KUENHOLD is Vice President, W. S. Tyler Co., Cleveland.



UPPER: Integrally balanced positive circle-throw screen featuring stationary air-seal enclosure. LOWER: Suspended-type two-bearing unbalanced circle-throw screen.

separation than it could if the feed were 90 pct coarser. Many are under the mistaken impression that a simple problem is at hand if it is necessary to pass only a small percentage of feed through the screen.

Screen capacity is more closely related to screen width than to length. Thorough separations, on the other hand, particularly where there is a preponderance of oversize, require more emphasis on length to accomplish stratification and give near mesh particles more opportunities to pass the openings.

Method of Mounting Screens: Most vibrating screens are designed so that they can be either suspended* or base-mounted to building structure.

* Flexible cable is best for suspension.

When base-mounted they must be firmly bolted to the supporting structure or mounted on vibration dampeners.

The natural frequency of the supporting structure, whether suspended or base mounted, should be at *least* 1.5 times the screen speed and largely dependent upon the deflection of the loaded structural members. This frequency varies inversely as the square root of the deflection; or the greater the deflection, the lower the frequency.

Several base-mounting methods are possible with four-bearing, circle-throw, integrally balanced vibrating screens. Particularly attractive are the methods allowing the machine to rest unattached on brackets designed to match the structure. With this arrangement, complete machines are lifted in and out of operating positions with very little delay.

Slope: The optimum slope of inclined vibrating screens is that which will handle the greatest volume of oversize and still remove the available undersize required by the standards of the particular operation. To separate a material into coarse and fine fractions, the bed thickness must be limited so that vibration can stratify the load and allow fines to work their way to the cloth and pass through the opening. Increased slope naturally increases the rate of travel, and at a given feed rate it reduces the bed thickness. It is surprising how many operators miss this point and mistakenly flatten a screen when it should be elevated to increase effectiveness of separation.

Feed Arrangement: Feed must be delivered, at reasonable velocity, across the full width of the screen. Excessive velocity not only causes poor separation but also increases tremendously the wear on screen surfaces and related handling equipment. It is difficult to meet these requirements if the material is not delivered parallel to the longitudinal axis of the screen.

Gravity chutes most commonly deliver dry material to the screen. This can be successfully accomplished at minimum cost *only* with free-flowing material, where maximum surges are within screen capacity. Gravity chutes should be designed to incorporate the basic shelf, or stone-box, which helps to control velocity, wear, and distribution and even levels out surges.

A separate feeder is generally needed to deliver sticky materials. Such devices should be carefully considered if there are exceptionally large lumps, or fine separations where close sizing is required. It is preferable to equip aprons, belts, drags, and electrically vibrated feeders with speed controls.

Screen Problem Data

I. Full Description of Material Involved:
   Include
   - A. Name and type of material
   - B. Weight per cubic foot
   - C. Physical characteristics
     1. Hardness
     2. Characteristic particle shape
     3. Flow characteristics—free flowing, sluggish or sticky
     4. Percent of moisture
     5. Temperature

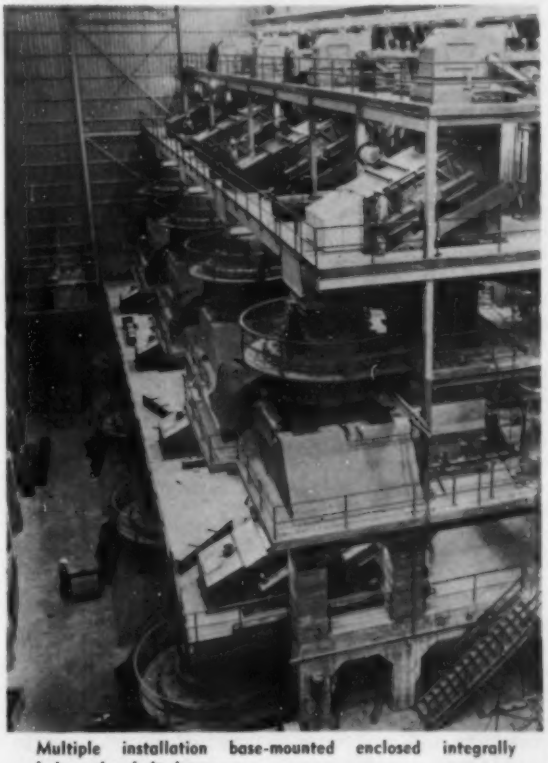
II. Normal and Maximum Total Rate of Feed to Screen

III. Sieve Analysis of Screen Feed:
   Include
   - A. Percent coarser and finer than point of separation
   - B. Maximum lump size
   - C. Complete sieve analysis if available

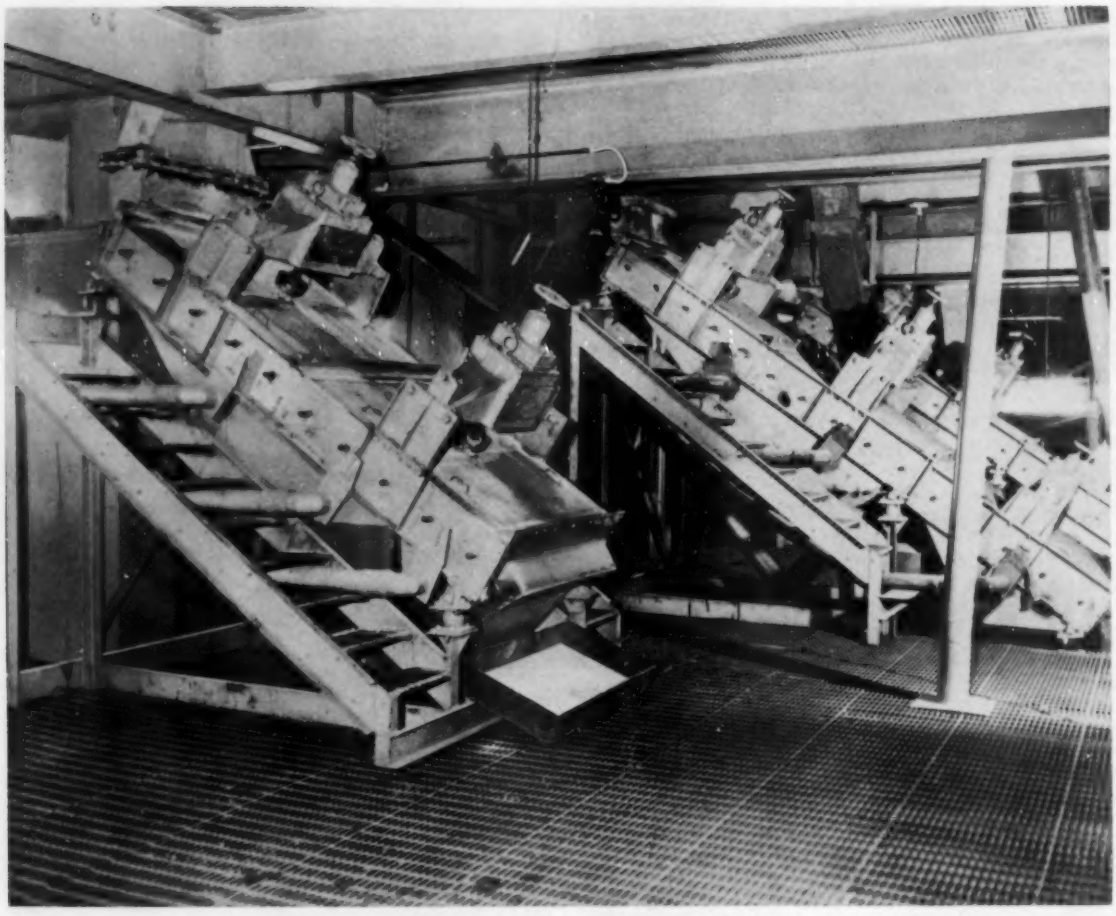
IV. Separation or Separations Required and Purpose. Choice of Slotted or Rectangular Openings

V. Screening Accomplished, Dry or Wet, and Amount of Water Available

VI. Other Important Factors:
   Include
   - A. Method of delivering feed to screen
   - B. Open or closed circuit
   - C. Open or enclosed screens
   - D. Previous screening experiences with the material
   - E. Flowsheet or description of related equipment
   - F. Operating hours per day
   - G. Power available
   - H. Space limitations



Multiple installation base-mounted enclosed integrally balanced unbolted screens.



Electrically vibrated screen with vertical linear reciprocation showing air suction pipe.

Wet sizing is best accomplished if the solids are slurried before delivery to the screen. The proportion of water to solids depends on many factors, but a ratio of 2:1 is generally ample.

If not pumped, a slurry is usually flumed or laundered to a screen. Launders should be designed at minimum slope, consistent with a flow that will flush solids uniformly. Velocity of the slurry, on introduction to the screen, can often be controlled by headers. Overflow weirs are used to advantage for this purpose, with slurries involving fine solid suspensions.

Skirting: Weight should not be added to the vibrated body of a screen without consulting the manufacturer as this could well jeopardize the performance, balance and bearing life. This condition is most frequently violated by attachment of side plate skirts and extensions. These matters must be considered when the installation is designed, to provide proper material transfer and adequate stationary skirting to confine large lumps or bounding oversize.

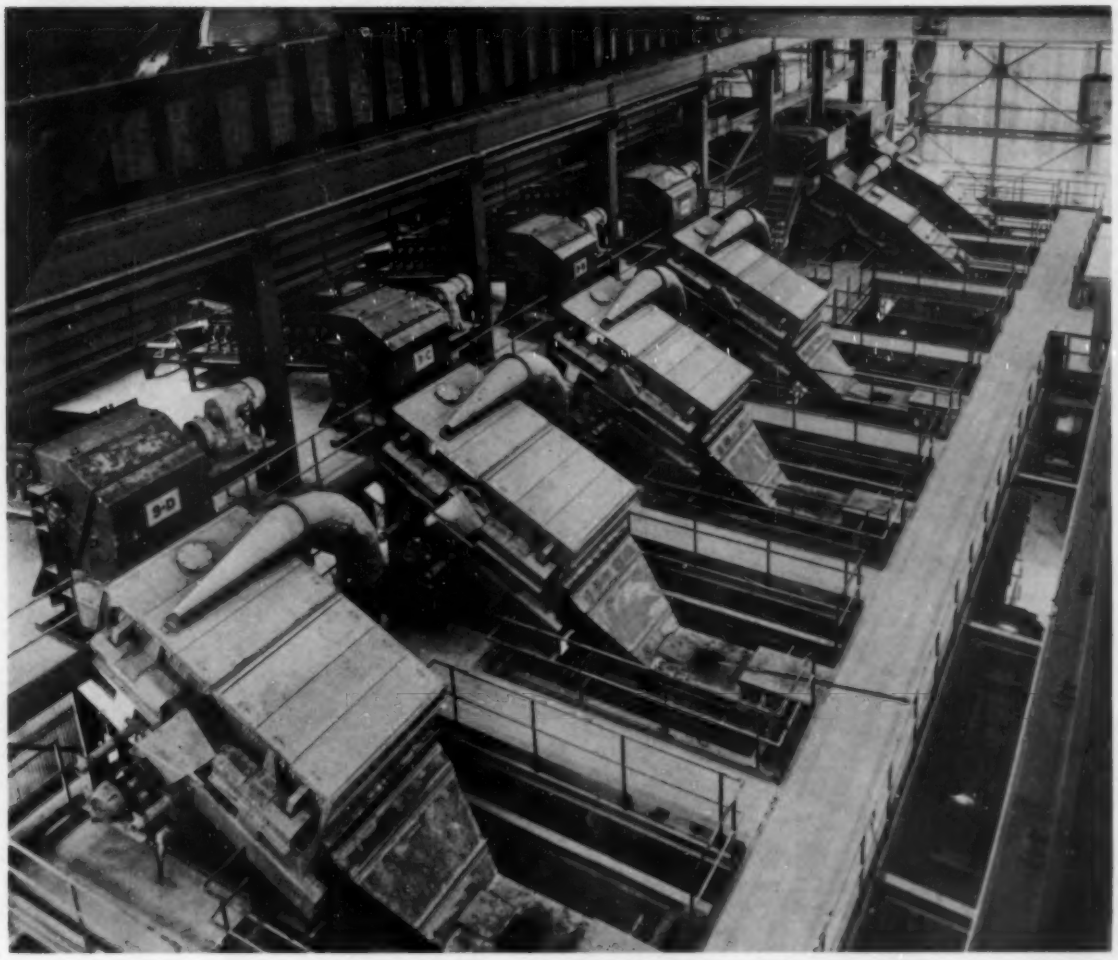
Access for Maintenance: Without convenient access, maintenance is not regularly attended to. There should be safe platforms or walkways, clearance to handle screen sections and, of course, space for overhaul. Do not button-in a machine with fixed chutes, skirts or enclosures.

Multiple Surface Machines: Multiple surface screens are employed to advantage in circuits involving several separations or are used to provide a protective deck for a sizing surface.

Convenient access to all surfaces is sacrificed when more than two are used and, in fact, on some machines even a second surface is inaccessible. Visibility of lower screens is lost during operation, and in wet sizing it is difficult, if not impossible, to apply water as effectively to lower surfaces as on the top deck.

Dust Control: A screening operation promotes dust, and confinement or exhaustion of these airborne solids has become increasingly important. With certain materials mist water sprays, or even steam, effectively blanket dust but have limited application because additional moisture affects screening adversely.

Hoods should be mounted and supported independently of the vibrated body. If the enclosure is to be effective, dust should be controlled by air suction. In fine screening, air flow should be downward through the cloth so that separation will not be impeded. The enclosure should be designed to pre-



Multiple installation base-mounted integrally balanced screens of enclosed construction with exhaust ducts.

serve accessibility to the interior of the screen. Some screen manufacturers offer stationary air seal enclosures with quickly removable covers mounted on the screen base.

Application of Water: Proper application of water greatly assists sizing operations of 1 in. or finer. Water overcomes the tendency of most materials to agglomerate and facilitates finer screening than would be possible on a damp or even dry basis.

Water is most frequently introduced to a screening surface by sprays or overflow boxes. Many screen manufacturers incorporate solid troughs in the screen deck to accept the pressure sprays and repulp solids. Spray pipe assemblies should not interfere with screen cover changes. It is best to incorporate a valve in each line of sprays so that the volume of water can be adjusted.

Closed Circuit Vs Open Circuit: Vibrating screens are often installed to supplement reduction equipment in crushing and grinding circuits. In a closed arrangement, material can leave the circuit *only* by passing through the screen, whereas in open circuits the product consists of a combination of the material passing through the reduction equipment as well as the screens.

Three functions are accomplishd by screens in a closed circuit:

1) Fine material is bypassed, reducing the tonnage to succeeding reduction equipment, preventing clogging and limiting over-reduction.

2) Top size of the circuit is definitely controlled.

3) Reduction work is balanced between stages to facilitate lowest overall power consumption.

In an open circuit, vibrating screens can accomplish only two purposes:

1) Fines are bypassed around reduction equipment.

2) Particle size is partially controlled.

It is well established that closed circuit crushing or grinding facilitates efficient reduction. Too often the performance of reduction equipment is handicapped in open circuits where it is necessary to set a crusher to control the top size of the product.

Potential advantages of a closed circuit should be carefully weighed against the disadvantages. Disadvantages consist simply of the requirement for more screen area (proportional to the size of the circulated load) and conveyors or handling equipment to return the screen oversize to reduction equipment.

Jet Piercing With Converted Churn Drills

Five hundred horsepower, contained in a jet no longer than 18 in., gives converted drills new punch.

by T. M. Howell

JET piercing is a licensed process developed by Linde Air Products Co. Experiments with this method lapsed during World War II, but in the decade that followed the process was expedited.

Two types of drills mount the jet piercing equipment for blastholes. The turntable of one machine rotates the complete stem system as well as the blowpipe, which emits three individual flames at different levels. Depth penetrated is limited by length of the blowpipe mounted in the rotary mechanism. This machine has successfully drilled blastholes in Minnesota taconite.

The second type of mounting equipment is usually constructed by converting a churn drill in the field. Suspended from a wire cable, the blowpipe emits a single vertical flame, and depth of hole is not considered critical at less than 200 ft. Jet piercing with churn drill units will be considered here.

The Jet Compared with Industrial Flames: Various fuels and types of flames have been developed for specific uses in industry: the air-natural gas or air-oil flame in open hearth and other steel-making furnaces; natural gas-air or propane-air flames for heat-treating furnaces; oxy-propane and oxy-acetylene natural gas flames for finishing glassware; and the oxy-acetylene flame for welding and cutting. All these flames have two common denominators:

1) Flame velocity is below the acoustic velocity of the gases involved.

2) Ignition of gases takes place outside the burner itself.

With the jet flame, by contrast, combustion occurs inside a rocket-type burner similar to those being developed for military use. A liquid hydrocarbon fuel, kerosene or low viscosity fuel oil, is combined with high purity oxygen to produce a flame having a temperature above 4000°F. Depending on burner design, flame velocity is 4000 to 6000 fps. At normal pressure and temperature conditions, velocity is about 6000 fps, more than five times the speed of sound in air. With these combined characteristics —high temperature and very high speed—the jet or rocket flame differs radically from the commonly used industrial flame, which averages 400 to 700 fps. In terms of diesel engine efficiency, the mechanical energy is equal to 500 hp, contained in a flame no more than 18 in. long and 2 in. diam.

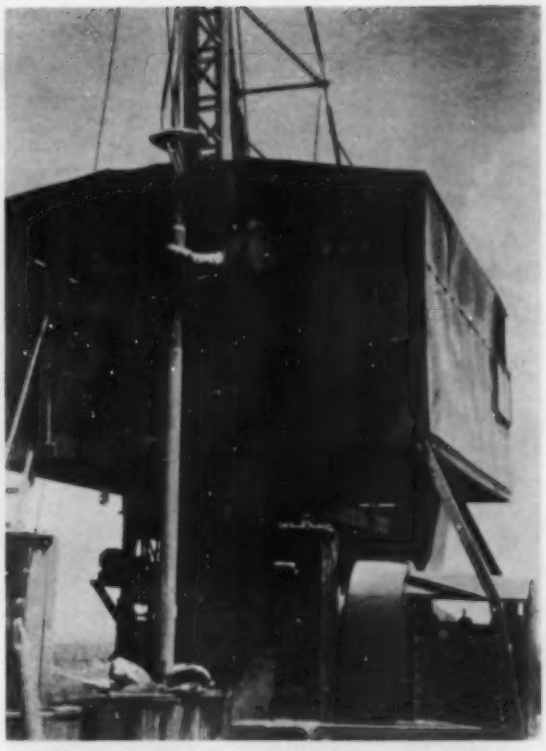
Jet Action in Drilling: Jet piercing does not burn like acetylene drilling; neither does it fuse, since melting is undesirable with this process. When the flame impinges on certain types of rock and ore, it causes a thin layer to expand and break away from the base material. The dynamic action of the jet blows the broken rock particles out of the path of the flame, exposing new rock. This constant flaking away of rock particles is called *spalling*.

In jet piercing with the modified churn drill rig, the operator goes by cable feel. Blowpipe oscillation is started after the flame is lighted, and the blowpipe is lowered until it contacts the bottom of the hole. The operator then retracts the blowpipe about 6 in., allows it to oscillate in this position a few seconds, and starts lowering again. Speed is governed by the ease with which the rock spalls.

In the jet piercing process water serves three purposes: 1) It acts as a coolant to preserve the combination chamber and nozzle of the burner. 2) It quenches and embrittles any material in the rock that may have been fused by the flame. 3) A large portion of the water turns to steam, carrying sand out of the hole.

Class of Rocks Pierced: The harder the rock, the more readily it spalls. The class of rocks that can be

T. M. HOWELL is General Production Manager at the Big Rock Stone & Material Co., Little Rock, Ark.



LEFT: (Above) Jet flame can be seen in lower center. (Below) Storage facilities one half mile from drill site provide for 300,000-cu ft supply of liquid oxygen, as delivered, and for 150,000 cu ft in gaseous state ready for use. RIGHT: Hoses near top of picture carry oxygen, kerosene, and water to blowpipe.

pierced includes quartz, quartzite, sandstone, granite, taconite, dolomite, rhyolite, and syenite. Some types of traprock can be pierced, but traprock spalls inconsistently. Most basalts, gabbros, and traprocks cannot be pierced economically at this time. High concentrations of mica and plagioclase feldspar offer considerable resistance by forming a melt, or collar. Limestone cannot be pierced at all.

At the Big Rock Stone & Material Co. sandstone quarry in Little Rock, Ark., churn drills produced satisfactory 6-in. blastholes for many years, averaging 6 ft per hr on 175-ft face. In 1951 it was determined that production facilities were to be relocated and expanded at a new deposit—a dense, tough nepheline syenite of igneous origin. Here the churn drills averaged only 1½ ft per hr. Bit gage life dropped from 15 ft per sharpening to about 4 ft. With the designed capacity of the new operation, 250 ft of hole would be required when transition was completed. This meant at least ten churn drills, working at peak efficiency, and at least two bit dressing facilities.

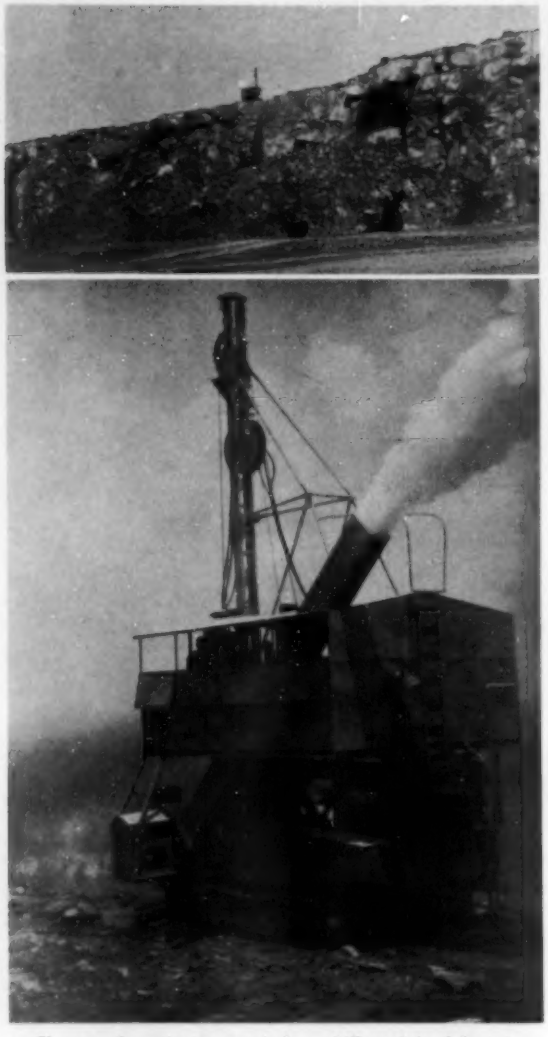
A survey of drilling methods revealed that jet drilling was being carried out successfully in granite deposits of the Southeast. It was found that under laboratory conditions the nepheline syenite could be drilled at about 1 fpm. After related factors had been determined, it was decided that this method should be installed at the new quarry.

Conversion of Existing Equipment: A Bucyrus-Erie 27T churn drill was converted to a jet piercing drill by company personnel, following a design prepared by Linde Air Products Co. This was accomplished by revamping the spud beam on the churn drill to produce a 4-in. spudding action instead of the 18 to 20-in. stroke normally used on the churn drill. The mast was shortened and the springing device at the boom point sheave was removed. An additional sheave consisting of a narrow flat drum was installed beneath the boom point sheave to feed the hoses from the drill platform into the same path as the drill cable supporting the blowpipe. These hoses, attached to the drill cable, carry oxygen, kerosene, and water into the hole. A fan, together with necessary duct work, was installed with a collection chamber at the collar of the hole to exhaust the cuttings and steam blown from the hole to a safe distance from the operator. The operator's platform was changed to a location 10 ft above the ground and drill controls were extended to this point. Process controls were added, including flow meters, gages, and pumps for delivering water, kerosene, and oxygen to the blowpipe at the right volumes and pressures.

The propelling and spudding mechanism continues to use the source of original power, 60 cycles, 440 v. Control pumps, lighting, and relays added to this source raise the total to 30 hp.

Storage Facilities: Approximately 40 gal per hr of kerosene are consumed, at 100 psi. It is important that the water be uncontaminated so that hoses, pipes, and blowpipe orifices will not be clogged.

A 2-in. welded steel pipeline delivers oxygen at 10,000 cu ft per hr, 70°F, and 180 psi from a combination liquid-gas storage unit half a mile from the drill site. Oxygen is delivered by truck or rail by Linde Air Products Co., which owns and maintains both the storage and mobile transportation units. There are 300,000 cu ft of storage for the liquid state



Close-up shows jet-converted churn drill used in Arkansas sandstone quarry. Upper view shows same machine atop 140-ft bank. Jet drills are also in use in granite quarries in the Southeast.

and 150,000 cu ft of storage for the gaseous state, with automatic provisions for conversion from liquid to gas. Oxygen is delivered as liquid and stored at 15 psi, −300°F. Gas is stored at 1800 psi, 70°F. All valves, pipes, hose, and in fact any surface exposed to the oxygen must be specified as oil-free or must be pickled in a caustic-soda solution at the site to prevent the violent reaction that occurs with contact of oxygen and oil. This is not a complex problem, since no reaction has occurred at this site.

Operating the Drill: At the lower end of the blowpipe—a 5-in. cylinder about 20 ft long—there is a mixing chamber where the kerosene is burned in the presence of oxygen. The burner is lighted at the top of the hole.

A 4-in. spudding action is used at all times. If the material being drilled melts, a hammer-type tool is lowered to break the hardened melt with a spudding action into small pieces that can be blown from the hole by jet velocity.

Some layers of material encountered during drilling do not lend themselves to spalling. Also there may be open seams, either inherent in the deposit or opened up by previous blasting in the vicinity. In this case velocity is dissipated into the open seam and the heat retained is the major cause of melting. The hole itself is convoluted, and although minimum diameter is about 5½ in., average area is the same as that of a 10-in. diam cylindrical hole. Drilling can be slowed to produce a hole of almost any reasonable volume. Change of drill rate can be used to create a large chamber at the bottom of the hole in an area where dynamite factors must be increased for good fragmentation. If the principle is applied to full advantage, it becomes necessary to use the tons per foot of hole, rather than footage drilled, as a basis for comparison with other types of drilling. Because face height at the quarry under consideration averages 150 ft, backbreak during blasting does not allow blastholes smaller than 10-in. diam. If smaller holes are used, the drill cannot be moved close enough to the vertical quarry face for a normal pattern of hole burden and spacing. Drilling has averaged 18 ft per hr over a four-year period.

Charging the Blasthole: Almost without exception, blasting agents are poured into a jet-drilled hole to take full advantage of space, particularly at the bottom. Where there is more area than is needed at any depth of hole, blasting agents of lower density are used, sometimes with inert materials. However, a solid column of explosives is maintained throughout—no decking is attempted. Cylindrical cartons of explosives can be placed with loose explosives packed around the cartons. This practice of utilizing the energy at hand to produce varying sizes of hole at any desired depth of blastholes is one of the most important advantages of the method.

Economics of Jet Drilling

The following factors, if evaluated in any given location, will establish a formula for comparison of jet piercing with other methods:

1) To determine whether or not the material is spallable, laboratory and field tests must be made before any investment can be considered. It is believed that over a long period the method will average one third of the production indicated by ideal laboratory conditions. This figure should be used in computing costs.

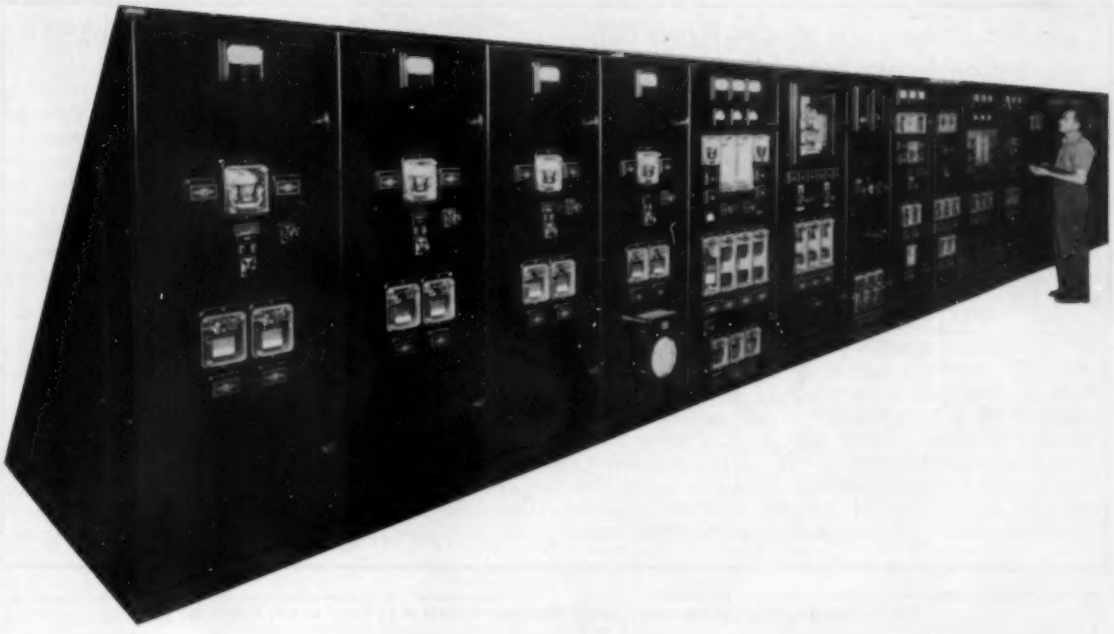
2) Costs should be computed for the following materials as delivered to the drill site: kerosene; water in a pure state; electrical power; and oxygen supply, including royalty payments to the patent holders, Linde Air Products Co. (Payment is based on amount of fuel used and not on oxygen consumed.)

3) It can be assumed that labor costs will parallel those for other types of drilling, both in amount and in rates.

4) Maintenance costs will consist of replacing hose, blowpipes, and the usual churn drill parts. These should be about 10 pct of other direct costs and are not considered excessive.

5) Capital investment is low if the cost of the drill to be converted is not considered. Generally the cost of oxygen storage is assumed by the supplier. With these conditions, capital investment should be 20 pct of the cost of drilling equipment for any comparable method.

6) In many cases there are excellent reasons for being able to change the size of the blasthole at any desired depth. The economic value of this procedure must be given full consideration.



Mill Operating Records and Accounts

In this article a hypothetical case is assumed, with a series of report forms and their use described to show what information can be obtained from the data readily available.

by Nathaniel Herz

IN the operation of any ore processing plant, no matter what beneficiation process or combination of processes may be used, certain fundamental figures are regularly needed for essential records and accounting. These include amounts of ore treated and products made, with their assays, as well as quantities of labor and supplies used, with their cost. Usually labor and supplies are broken down and allocated to certain operations by the accounting department, and resulting tabulations are available for study by the milling plant management. However, to avoid too many minor details that would make these reports cumbersome and involved, much information that could be useful to the plant operator is often consolidated in such a manner as to have lost a considerable part of its value.

To clarify this point, it may be stated that top management is most concerned with production figures and cost of production, while the plant operator is also interested in quantities of labor in man-hours and amounts of supplies used. Due to varying unit prices of labor and supplies, comparisons on a dollar basis alone are often misleading. With rising unit costs of the past few years now about twice as high as they were a few years ago, constant study of quantities involved is required to improve efficiency and productivity.

The flowsheet of this plant assumes a simple two-stage recovery of lead and zinc by flotation, after three stages of crushing and two of grinding. This does not mean that the writer advocates the type of crushing and grinding shown in the accompanying flowsheet as being the best for any lead-zinc ore; neither does he recommend the particular flotation reagents as universally applicable. The flowsheet was made up to include a variety of operations desired for the type of report forms shown.

The general system of allocation of accounts by numbers is shown in figure No. 2. It is assumed that account numbers of five digits are to be used for the charging of every item and that the first digit is the departmental number. The second digit represents the particular section of the processing, such as crushing, grinding, and lead recovery. The third and fourth digits together represent either individual operations, or in some cases important operating

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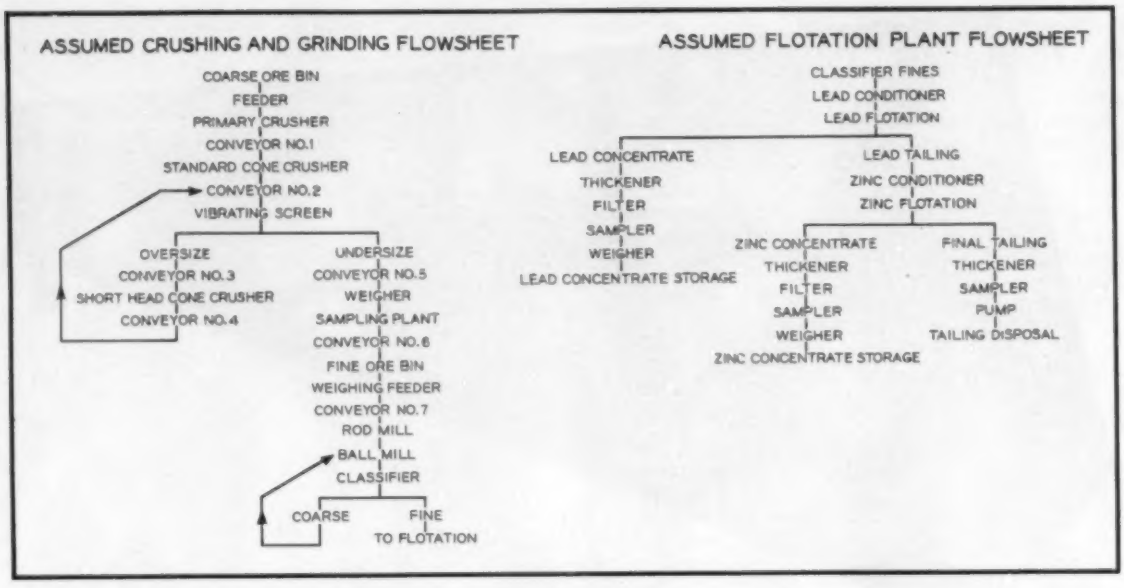


Fig. 1—Flowsheet of plant assuming a simple two-stage recovery of lead and zinc by flotation.

Account Numbers for Assumed Milling Plant

First Digit 5, Milling Department

Second Digit

1 Crushing
2 Screening, Conveying Etc.
3 Rod Mill Grinding Section
4 Ball Mill Grinding Section
5 Lead Recovery
6 Zinc Recovery
7 Tailings
8 General—unallocated

Fifth Digit

1 Labor, Operating
2 Labor, Maintenance
3 Supplies, Operating
4 Supplies, Maintenance
5 Other Operating Services
6 Other Maintenance Services
7 Power
8 Fuel

Third and Fourth Digits

00 Buildings
01 Grounds
02 Lighting
03 Heating
04 Water Supply
05 Fire Protection
06 Safety and First Aid

08 Coarse Ore Bin
09 Fine Ore Bin

10 Crusher Feeding
11 Primary Crushing
*12 Crusher Jaw Plates
13 Standard Cone Crushing
*14 Standard Cones and Bowls
15 Short Head Cone Crushing
*16 Short Head Cones and Bowls

20 Screening
*21 Coarse Screens (Top Deck)
*22 Fine Screens (Lower Deck)
23 Conveying
24 Weighing
25 Ventilation and Dust Control
26 Head Sampling

30 Rod Mill Feeding
31 Ore Weighing
32 Conveying
33 Rod Mill Grinding
*34 Rod Mill Liners
*35 Grinding Rods

40 Ball Mill Grinding
*41 Ball Mill Liners
*42 Grinding Balls

47 Classifying

50 Conditioning
51 Flotation
52 Concentrate Thickening
53 Concentrate Filtration
54 Concentrate Sampling
55 Concentrate Conveying
56 Concentrate Storage
57 Concentrate Loading

*60 Lime
*61 Zinc Sulphate
*62 Copper Sulphate
*63 Sodium Sulphite
*64 Cyanide
*65 Cresylic Acid
*66 Aerofloat
*67 Ethyl Xanthate
*68 Isopropyl Xanthate
*69 Pine Oil

*71 Separan

80 Tailing Thickening
81 Tailing Sampling
82 Tailing Pumping
83 Tailing Transportation
84 Tailing Storage or Disposal

90 Assaying (Routine)
91 Special Chemical Analyses
92 Screen Analyses (Routine)
93 Metallurgical Research
94 Design and Engineering
95 Accounting and Records

97 Supervision—allocated
98 Supervision—unallocated

* These are supply account numbers for office use only.

Fig. 2—General system of allocation of accounts by numbers. It is assumed that account numbers of five digits are to be used for the charging of every item and the first digit is the departmental number.

supplies for which separate costs are desired. The fifth digit identifies the item as consisting of labor, supplies, etc., and distinguishes between operating accounts and maintenance. It should be noted that there are some numbers available but not in use; in the case of the third and fourth digits they are grouped with gaps between groupings, permitting additions if desired. Supply account numbers are marked with an asterisk and are used by the accounting office only, on a monthly or other periodic basis.

A few examples of the use of these account numbers follow:

Maintenance labor on primary crusher	51112
Operating labor, ball mill grinding	54401
Aerofloat used in lead flotation	55663
Aerofloat used in zinc flotation	56663

A few words might be desirable here as to the line of demarcation between operating and maintenance charges. In the writer's opinion, replacement of machine parts designed to stand wear, but to wear out and be then replaced, should be considered as operating expenses. This applies to crusher jaws, cones, and bowls, even if the life is as long as several years. Replacements of broken windows, worn flooring, leaky valves, etc., are properly maintenance, as is repainting and similar rehabilitation.

In the fifth digit, labor of employes of the milling department is charged by using numbers 1 and 2, while other labor, for shopmen, electricians, etc., if not regularly on the departmental payroll should be considered as service charges, using the numbers 5 and 6. This enables the mill manager to differentiate between expenses originating within his own payroll and the cost of occasional service from other departments.

Charging Expenses to the Proper Account: Figure 5 shows a daily employe's time slip. The shift is noted for the purposes of record and to show whether the night shift differential is to be added to the normal daily rate. Hourly wage is indicated by the rate class. This designates the man's ordinary wage, but there is a space for showing a temporary change, to be used when a man is upgraded while substituting for an absentee in a higher class,

Fig. 3

GRINDING PLANT RECORD

MONTH OF _____ 195__

DATE	HOURS RUN	TONS GROUND	MOISTURE PCT	DRY TONS	TONS PER HOUR	ROD MILL					BALL MILL					KWH PER TON TOTAL
						KW HOURS		RODS, LB			KW HOURS		BALLS, LB			
						USED	PER TON	TO MILL	PER TON		USED	PER TON	TO MILL	PER TON		

Fig. 4

MONTHLY FLOTATION RECORD

MONTH OF _____ 195__

DATE	HOURS RUN	TONS MILLED	KWH USED	LEAD FLOTATION CONCENTRATE PRODUCED						ZINC FLOTATION CONCENTRATE PRODUCED						TAILING				
				WET TONS	WATER, PCT	DRY TONS	LEAD, PCT	LEAD UNITS	Zn, PCT	Zn UNITS	WET TONS	WATER, PCT	DRY TONS	Pb, PCT	LEAD UNITS	Zn, PCT	ZINC UNITS	TONS	Pb, PCT	LEAD UNITS	Zn, PCT	ZINC UNITS

Fig. 5

TIME REPORT _____ SHIFT	DATE ____	DEPT ____	MAN NO. ____	RATE CLASS ____
	WORK DESCRIPTION	ACCT NO.	HOURS	RATE CLASS IF CHANGED
	WORK STARTED AT ____	ENDED AT ____	TOTAL	

EMPLOYE'S SIGNATURE _____ SUPERVISOR'S SIGNATURE

Fig. 6

CRUSHER AND GRINDING MILL WEAR REPORT

COMPLETED ON _____ 19__

DESCRIPTION OF MATERIAL _____

MADE BY _____ RECEIVED _____

WEIGHT, LB ____ COST, $ ____ COST PER LB ____ ¢

DATE INSTALLED _____ REMOVED _____

LIFE IN DAYS _____ TONNAGE _____

DISCARD WEIGHT _____ PERCENT _____

POUNDS WEAR PER TON _____ COST, ¢ PER TON _____

NOTES ON WEAR, UNIFORMITY OR OTHERWISE, CRACKS, ETC

Fig. 7

CRUSHING PLANT RECORD

MONTH OF ____ 195__

DATE	HOURS RUN	TONS CRUSHED	MOISTURE PCT	DRY TONS	TONS PER HR	KWH USED	KWH PER TON

	PRI	STD	SHORT HEAD	MISC	TOTAL
KWH USED					
KWH PER TON					

Fig. 8

DAILY CRUSHING REPORT _____ 195__

STARTING TIME				
STOPPING TIME				
HOURS CRUSHING				

TOTAL HOURS _____

CAUSE OF DELAYS _____

WEIGHER TOTAL _____

PREVIOUS TOTAL _____

TONS CRUSHED _____

	PRI	STD	SHORT HEAD	OTHER
KWH METER				
PREVIOUS TOTAL				
KWH USED				

TOTAL KWH _____

Fig. 9

DAILY GRINDING REPORT

_____ 195__

ROD MILL HOURS RUN _____

HOURS IDLE _____

CAUSE OF DELAYS _____

WEIGHER READING _____ KWH METER _____

PREVIOUS READING _____ PREVIOUS READING _____

TONS GROUND _____ KWH USED _____

RODS TO MILL _____ LB

BALL MILL HOURS RUN _____

HOURS IDLE _____

CAUSE OF DELAYS _____

KWH METER _____

PREVIOUS READING _____

KWH USED _____

BALLS TO MILL _____ LB

Fig. 10

DAILY FLOTATION REPORT

_____ 195__

HOURS RUN _____

HOURS IDLE _____

CAUSE OF DELAYS _____

CONCENTRATES PRODUCED: LEAD _____ LB

ZINC _____ LB

CHEMICALS USED: POUNDS	LEAD FLOTATION	ZINC FLOTATION
LIME		
ZINC SULFATE		
SODIUM SULFATE		
COPPER SULFATE		
CYANIDE		
CRESYLIC ACID		
AEROFLOAT		
ETHYL XANTHATE		
ISOPROPYL XANTHATE		
PINE OIL		

KWH METER READING _____

PREVIOUS READING _____

KWH USED _____

Fig. 11

DETAILED CRUSHING PLANT COST — MONTH OF____195_

	LABOR		SUP-PLIES		SERV-ICES				TOTALS			
	OPT'G	MAINT	OPT'G	MAINT	OPT'G	MAINT	POWER	FUEL	OPT'G	MAINT	GRAND TOTAL	PER TON
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
ORE BINS												
FEEDING												
PRIMARY CRUSHING												
JAW PLATES												
STANDARD CONE CRUSHING												
CONES & BOWLS												
SHORT HEAD CRUSHING												
CONES & BOWLS												
SCREENING												
COARSE SCREENS												
FINE SCREENS												
CONVEYING												
WEIGHING												
DUST CONTROL												
HEAD SAMPLING												
OFFICE EXPENSE												
SUPERVISION												
TOTAL												

Fig. 12

DETAILED ZINC FLOTATION COST — MONTH OF____195_

	LABOR		SUP-PLIES		SERV-ICES				TOTALS			
	OPT'G	MAINT	OPT'G	MAINT	OPT'G	MAINT	POWER	FUEL	OPT'G	MAINT	GRAND TOTAL	PER TON
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
ZINC CONDITIONING												
ZINC FLOTATION												
COPPER SULFATE												
AEROFLOAT												
ISOPROPYL XANTHATE												
PINE OIL												
ZINC CONC THICKENING												
ZINC CONC FILTRATION												
ZINC CONC SAMPLING												
ZINC CONC CONVEYING												
ZINC CONC STORAGE												
ZINC CONC LOADING												
ASSAYING												
OFFICE EXPENSE												
SUPERVISION												
TOTAL												

Fig. 13

DETAILED GRINDING COST — MONTH OF____195_

	LABOR		SUP-PLIES		SERV-ICES				TOTALS			
	OPT'G	MAINT	OPT'G	MAINT	OPT'G	MAINT	POWER	FUEL	OPT'G	MAINT	GRAND TOTAL	PER TON
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
FEEDING												
WEIGHING												
CONVEYING												
ROD MILLING												
LINERS												
RODS												
BALL MILLING												
LINERS												
BAILS												
CLASSIFYING												
SCREEN ANALYSES												
OFFICE EXPENSE												
SUPERVISION												
TOTAL												

Fig. 14

TAILING DISPOSAL AND UNALLOCATED COSTS — MONTH OF____195_

	LABOR		SUP-PLIES		SERV-ICES				TOTALS			
	OPT'G	MAINT	OPT'G	MAINT	OPT'G	MAINT	POWER	FUEL	OPT'G	MAINT	GRAND TOTAL	PER TON
TAILING DISPOSAL:												
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
THICKENING TAILING												
SEPARAN												
TRANSPORTATION												
SAMPLING TAILING												
PUMPING TAILING												
DISPOSAL OF TAILING												
OFFICE EXPENSE												
SUPERVISION												
TOTAL TAILING COST												
UNALLOCATED EXPENSE:												
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
SPECIAL CHEMICAL ANAL												
METALLURGICAL RESEARCH												
DESIGN & ENGINEERING												
ACCOUNTING & RECORDS												
SUPERVISION												
TOTAL UNALLOCATED												

Fig. 15

DETAILED LEAD FLOTATION COST — MONTH OF____195_

	LABOR		SUP-PLIES		SERV-ICES				TOTALS			
	OPT'G	MAINT	OPT'G	MAINT	OPT'G	MAINT	POWER	FUEL	OPT'G	MAINT	GRAND TOTAL	PER TON
BUILDINGS & GROUNDS												
LIGHTING												
HEATING												
WATER SUPPLY												
FIRE PROTECTION												
SAFETY & FIRST AID												
LEAD CONDITIONING												
LEAD FLOTATION												
LIME												
ZINC SULFATE												
SODIUM SULFITE												
CYANIDE												
CRESYLIC ACID												
AEROFLOAT												
ETHYL XANTHATE												
LEAD CONC THICKENING												
LEAD CONC FILTRATION												
LEAD CONC SAMPLING												
LEAD CONC CONVEYING												
LEAD CONC STORAGE												
LEAD CONC LOADING												
ASSAYING												
OFFICE EXPENSE												
SUPERVISION												
TOTAL												

Fig. 16

LABOR DISTRIBUTION IN MANHOURS — MONTH OF____195_

					YR TO DATE			
	OPER-ATING	MAINTE-NANCE	TOTAL	PER DAY	OPER-ATING	MAINTE-NANCE	TOTAL	PER DAY
BUILDINGS								
GROUNDS								
LIGHTING								
HEATING								
WATER SUPPLY								
FIRE PROTECTION								
SAFETY & FIRST AID								
ORE BINS								
CRUSHING								
SCREENING, ETC								
HEAD SAMPLING								
ROD MILLING								
BALL MILLING								
LEAD RECOVERY								
ZINC RECOVERY								
TAILING DISPOSAL								
CHEMICAL LABORATORY								
METALLURGICAL TESTING, ETC								
DESIGN & ENGINEERING								
ACCOUNTING & RECORDS								
SUPERVISION								
TOTAL								

Specimen forms that may be used for mill operation records.

Fig. 17

MILL SUPPLIES, MONTH OF _____ 195_

	CURRENT MONTH	PER TON MILLED	YEAR TO DATE	PER TON MILLED
TONS MILLED				
GRINDING RODS, LB				
GRINDING BALLS, LB				
KWH: CRUSHING				
ROD MILLING				
BALL MILLING				
FLOTATION				
OTHER USES				
TOTAL				
CHEMICALS IN LEAD FLOTATION:				
LIME				
ZINC SULFATE				
SODIUM SULFITE				
CYANIDE				
CRESYLIC ACID				
AEROFLOAT				
ETHYL XANTHATE				
IN ZINC FLOTATION:				
COPPER SULFATE				
AEROFLOAT				
ISOPROPYL XANTHATE				
PINE OIL				
SEPARAN				

Fig. 18

SUMMARY OF METALLURGY

MONTH OF _____ 195_

DATE	CALCULATED HEADS: TONS MILLED	CALCULATED HEADS: PCT Pb	CALCULATED HEADS: PCT Zn	CALCULATED HEADS: UNITS Pb	CALCULATED HEADS: UNITS Zn	Pb CONS: DRY TONS	Pb CONS: UNITS Pb	Pb CONS: UNITS Zn	Zn CONS: DRY TONS	Zn CONS: UNITS Pb	Zn CONS: UNITS Zn	TAILINGS: DRY TONS	TAILINGS: UNITS Pb	TAILINGS: UNITS Zn	PCT DISTRIBUTION: LEAD: RECOVERED IN LEAD CONC	PCT DISTRIBUTION: LEAD: LOST: IN ZINC CONC	PCT DISTRIBUTION: LEAD: LOST: IN TAILS	PCT DISTRIBUTION: ZINC: RECOVERED IN ZINC CONC	PCT DISTRIBUTION: ZINC: LOST: IN LEAD CONC	PCT DISTRIBUTION: ZINC: LOST: IN TAILS

Fig. 19

MONTHLY COST SUMMARY _____ 195_

	LABOR	SUPPLIES	SERVICES	POWER	FUEL	TOTAL	PER TON
BUILDINGS & GROUNDS							
LIGHTING							
HEATING							
WATER SUPPLY							
FIRE PROTECTION							
SAFETY & FIRST AID							
ORE BINS							
CRUSHING							
SCREENING, ETC							
ROD MILLING							
BALL MILLING							
LEAD RECOVERY							
ZINC RECOVERY							
TAILING DISPOSAL							
DEPARTMENT OFFICE							
SUPERVISION							
TOTAL							

Fig. 20

RECORD OF CHEMICALS USED

MONTH OF _____ 195_

DATE	LEAD FLOTATION: LIME	LEAD FLOTATION: ZINC SULFATE	LEAD FLOTATION: SODIUM SULFITE	LEAD FLOTATION: CYANIDE	LEAD FLOTATION: CRESYLIC ACID	LEAD FLOTATION: AEROFLOAT	LEAD FLOTATION: ETHYL XANTHATE	ZINC FLOTATION: COPPER SULFATE	ZINC FLOTATION: AEROFLOAT	ZINC FLOTATION: ISOPROPYL XANTHATE	ZINC FLOTATION: PINE OIL	ZINC FLOTATION: SEPARAN

or when he is temporarily called upon to do work calling for a higher hourly wage. These time reports are to be carefully checked and signed by the employe and his immediate supervisor, usually a shift boss or foreman. Before being sent to the accounting office they should again be checked by the mill clerk to guard against errors.

Supply charges for the special mill supplies for which there are individual account numbers are made on a weekly or monthly basis from the mill records, with a check by actual physical inventory once a month. Other miscellaneous supplies are obtained as needed from warehouse stocks on signed orders bearing the proper account numbers, and totals to be charged to each account number are accumulated throughout each accounting period.

Actual accounting procedures need not be discussed here, as any approved system, either manual or mechanized, may be used. A monthly basis of accumulation of totals is assumed here, although other periods may be used.

Crushing plant operations are reported daily on the form shown in Figure 8 and the figures posted daily in the mill office on the monthly record, Figure 7. In all monthly record sheets several extra lines are desirable so that subtotals for each week (or other desired period) may be recorded, using ink of a distinctive color.

Forms for Grinding Plant: Specimen forms are shown for the grinding plant. Their use is similar to those for the crushing plant. A special report is shown for parts such as mill liners, crusher jaws, cones, and bowls.

Daily and monthly flotation records are shown, as well as a monthly record of chemicals used. From the monthly records, a summary tabulation of major mill supplies used per month and per ton may be made. This completes the daily data furnished by the mill operatives and the monthly tabulations made therefrom.

One of the most important records shows tonnages and grades of ore and products, as well as recoveries and losses by both quantity and percent. When these figures are posted daily, any change of ore character or aberration in treatment is promptly revealed.

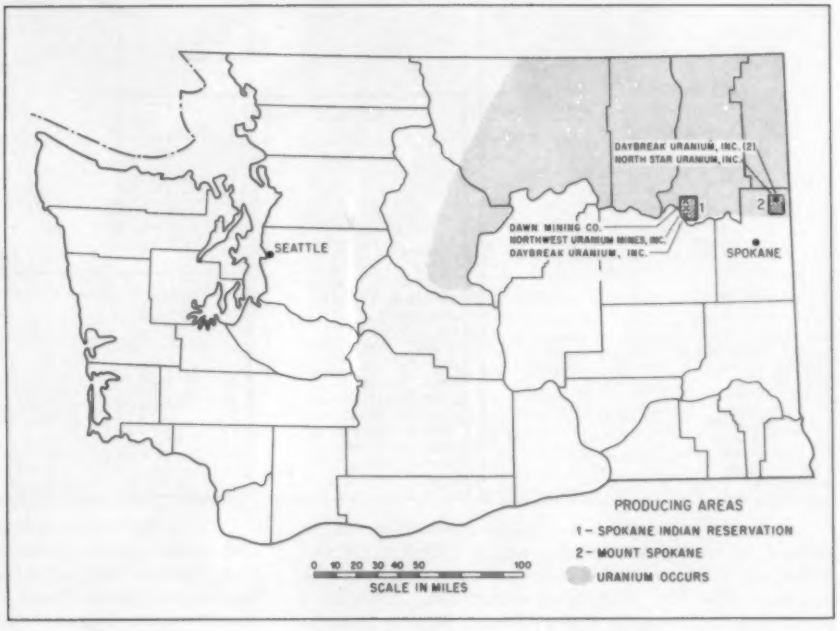
The remaining reports are monthly summaries, all of which may not be required regularly in full detail, but for which all the necessary information is available in the operating ledger, the supply accounts, and the payroll accounts. One of these is the type of report usually furnished to management by accountants and is an excellent summary. Any unusual increase in cost of one operation can be readily noticed in this report, but sometimes it is difficult to determine the cause of such increase without further study of more detailed tabulations.

Five forms presented here are types of monthly itemized costs. In some cases certain items could be consolidated for routine records, while in others more details may be wanted. For example, sometimes segregation of services as to source (mechanical, electrical, and construction) might be desirable.

Finally, there is a form for labor distribution by manhours which is very useful for study leading to economy in the use of labor, as it is not influenced by variations in wages, cost of overtime or shift differentials, or by fringe benefits such as holiday and vacation pay.

For all these records and tabulations, no special data not regularly available in the course of normal plant operation or control need be obtained. A series of specimen reports and records has been presented as an indication of what can be done by using figures normally recorded on daily reports or available from meter readings and other sources. The general plan can be adapted to any type of process, and the items expanded or consolidated to meet the needs of the operating staff of a particular plant. A regular study of reports such as these shown should lead to efficient and economical operation.

Uranium Deposits of Northeastern Washington



The boom period is over, and success must be measured by production and reserves rather than promotion and publicity.

by H. W. Norman

DURING the first few years of the new atomic age the Colorado Plateau was the focal point of uranium exploration. There was little incentive to expend time and effort in an area so far removed from the known deposits as the Pacific Northwest, and there were too few local prospectors to cover the vast territory involved. In 1949 the AEC established an exploration office in Spokane to evaluate the uranium potential of the northwestern states. Interesting occurrences were found in the Coeur d'Alene district in Idaho and in the Boulder Batholith of central Montana, but the AEC discontinued the Spokane office in 1952, and for the next two years prospecting in the area was negligible.

In April 1954 John and James LeBret, prospecting on the Spokane Indian Reservation with an ultra violet lamp, located an occurrence of the fluorescent uranium mineral autunite. This discovery was not announced until the following September, after a lease had been granted by the Spokane tribe. Exploratory drilling carried on by the AEC throughout the winter verified the existence of a commercial orebody. This property, the Midnite mine, has since developed the largest known ore reserve in the district.

Early in 1955 a second discovery of significance was made near Mt. Spokane, 50 miles east of the Spokane Indian Reservation. Drilling on the spot where some unusual green crystals had been found 13 years earlier, the AEC verified a new commercial orebody. Now the Daybreak mine, this deposit has produced the finest specimens of meta-autunite known to exist.

During 1955 the uranium boom gained momentum, and reports of new discoveries, newly organized mining companies, and new and infallible methods of *doodlebugging* were commonplace. Many reported strikes were authentic occurrences of uranium, or sometimes thorium, but with few exceptions they were not of commercial size or grade. By the end of the following year prospecting activity

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had subsided to a fraction of its peak intensity, and many of the newly formed companies had become discouraged with the high cost of exploring their leases as compared to the low ratio of success. Many promising finds had been made, but few had been satisfactorily proved or disproved. Shipments of commercial grade uranium had been made from five properties, and at least one other sizable orebody had been blocked out. Some 11,000 tons had been shipped by the end of 1956.

Actually there was little incentive to ship, following the termination in 1955 of AEC off-plateau contracts. The cost of transportation to the closest processing plant, located at Salt Lake City, was prohibitive, especially after initial production bonuses were exhausted. Undoubtedly the most encouraging event of 1956 was the announcement that AEC had signed a contract with Dawn Mining Co. for construction of a 400-tpd processing mill at Ford, Wash. Most of the mill's requirements will be met by Dawn's Midnite mine, but provision is made for the purchase of 100 tpd on a custom basis. Custom purchasing, though limited, will enable small producers to meet operating costs while determining the full extent of their reserves. Western-Knapp Engineering Co. is scheduled to complete the plant late this summer.

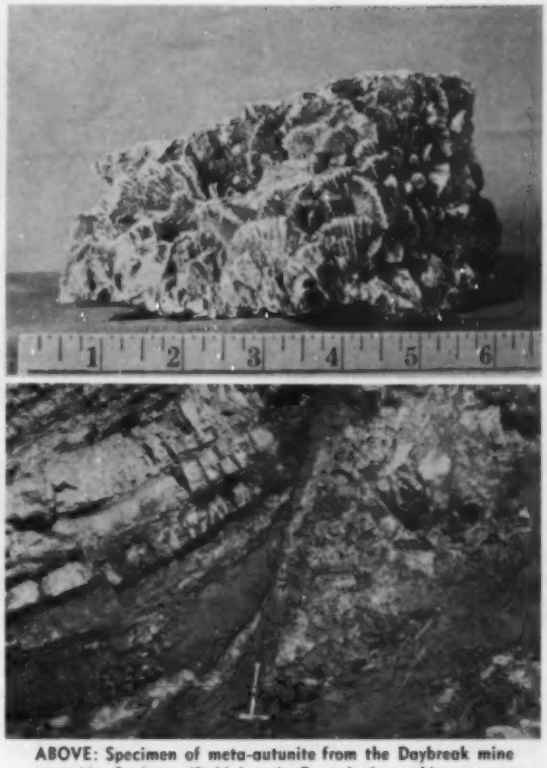
Geology

Commercial bodies of uranium are known to occur in three distinct geologic environments in northeastern Washington: 1) in and near the contact of granitic and metamorphic rocks, 2) in Tertiary sediments, and 3) in sheared and faulted zones within granitic intrusives. The mineralized contact zones and the sedimentary deposits occur on the Spokane Reservation, while the remaining type is found in the Mt. Spokane district, about 20 miles northnortheast of Spokane.

Contact Deposits: The best developed example of the contact zone deposits is the Midnite mine. This area is underlain for the most part by the Loon Lake granite, a late Cretaceous batholithic intrusive varying considerably in texture and composition. Within the main mass are occasional dioritic dikes or segregations, which appear to be unrelated to uranium deposition. The batholith intruded the Deer Trail group, a series of metasediments with a total thickness of possibly 30,000 ft, of which various lobes or roof pendants remain in this area of the reservation. The outcrop of this group extends about 30 miles north with widths up to 6 miles. The age is now generally considered to be Pre-Cambrian, although formerly it was referred to as lower Paleozoic. Phyllites and slates are the most abundant rock types within the group, but distinctive quartzite and dolomite formations are valuable aids in correlation. Within the contact aureole, schists and hornfels are common. Often the schists have a spotted texture as a result of numerous cordierite and andalusite porphyroblasts. Schistosity, where developed, is normally parallel to bedding planes except where distortion of the beds has taken place.

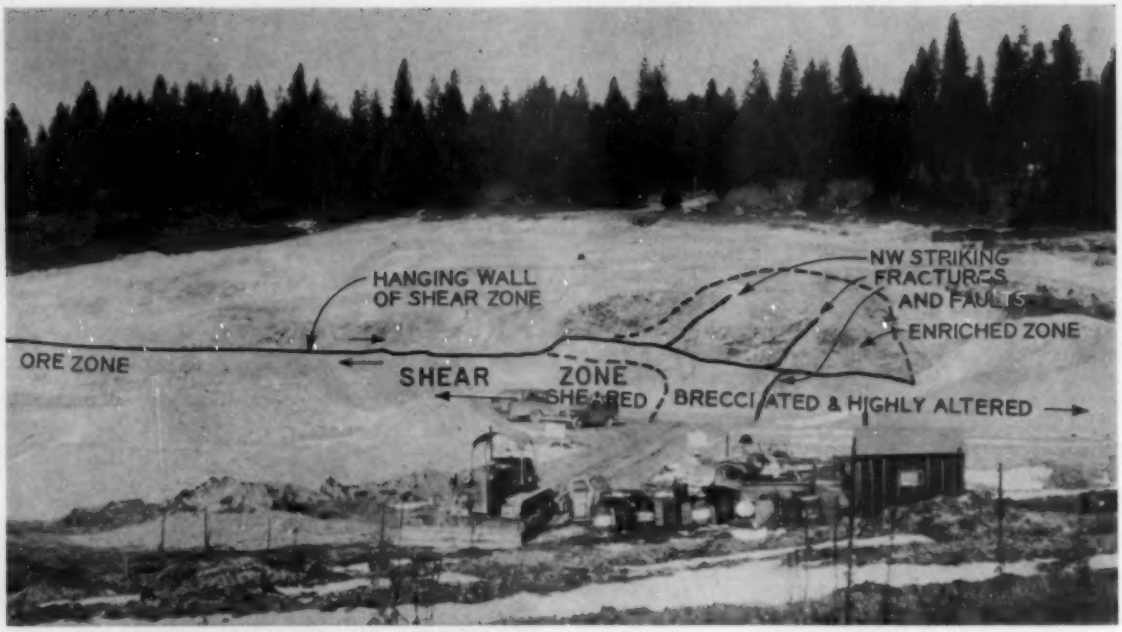
Midnite mine is located at a contact of the Loon Lake granite with the lowest member of the Deer Trail group. This member, the Togo formation, although predominantly phyllitic, has been altered to calc-silica hornfels and quartz-mica schists near the contact.

Quartzitic beds have been observed but do not constitute a high percentage of the rock. Some of the phyllite exhibits considerable calcareous content, and fractures may be filled with calcite. The strike of the contact approximately parallels the strike of bedding, averaging about N 15°E. Dip of the contact is irregular, ranging from horizontal to 70°E. The metasediments are on the west flank of an overturned anticline. Bedding dips from 55° to 65°E.



ABOVE: Specimen of meta-autunite from the Daybreak mine near Mt. Spokane (Dahl lease). Crystals from this property are the finest of their kind known to exist. BELOW: View north of the mineralized West fault on the Northwest Uranium Mines Inc. property on the Spokane Indian Reservation. Interbedded arkose and partially coalified plant remains on left, conglomerate on right. Sediments represent ore zone. The conglomerate is only slightly mineralized here.

Secondary uranium minerals were originally discovered in a zone of shearing at the contact and within the adjacent metasediments; deposition of the mineral is controlled to some degree by bedding planes and slips. In the metasediments uranophane seems to be the most abundant uranium mineral, although autunite is common and torbernite is occasionally observed. Leaching and redeposition have resulted in enrichment of the quartz-monzonite up to several tens of feet from the contact. However, on the granitic side of the contact zone only autunite, or more probably meta-autunite, is normally found, supporting the hypothesis of primary deposition in the metamorphic rocks with subsequent redistribution by meteoric waters. Uraninite has been found in drill cores from the metasediments as far as 100 ft from the contact. To date there has been no production from primary minerals, as all mining operations have been carried on in the oxidized surface zone. Although occurring in a contact zone, the uranium deposition is not believed to be a direct result of contact metamorphism. No significant replacement of the host rock by uranium minerals is evident. The primary control is apparently the shearing developed after emplacement of the batholith.



View north of a portion of the Daybreak mine (Dahl lease) near Mt. Spokane. Upper portion of east-striking shear zone, dipping 15° to 30° north in this area, is exposed in the face of the pit. Several of the northwest-striking intersecting mineralized structures are indicated. Such intersections appear favorable for ore deposition.

Volume changes during cooling as well as original stresses created by the intrusion resulted in shearing along the contact. Concentrations of uranium exist as individual bodies or pods scattered along at least a mile and a half of the sheared contact zone. Enriched zones may occur where transverse gash fractures intersect the major shear zone. The shearing is not confined to the metasediments but persists into the quartz-monzonite to an unknown degree. However, conditions for transportation or deposition of uranium were apparently unfavorable, as shown by the barren nature of shears within the igneous mass.

Pyrite is the most common associate metallic mineral, but it also occurs abundantly without accompanying uranium minerals. Pyrrhotite and molybdenite have been tentatively identified among the minor constituents. Calcite and quartz are the most abundant nonmetallic associates.

More than 50,000 ft of drilling has been done along the contact zone, developing sizable ore reserves. Exact figures are not publicized, but it has been stated that 500,000 tons are indicated.

Seven miles south of the Midnite mine a similar contact-type deposit has been exposed on Daybreak Uranium's Lowley lease. Here the Loon Lake formation is represented by a lithologic assemblage including granite, quartz-monzonite, and granodiorite. The contacting member of the metasedimentary series is a quartzite, believed to be younger than the Togo formation. Since the metasediments occur as roof pendants, correlation with other formations of the area is difficult, and the formational name has not been determined. The average strike of the sheared contact is approximately N 15°W, agreeing closely with the strike of the quartzite beds. Bedding dips from 50° to 70°E, while the contact dips from 45° to 80° in the same direction. A distinctive anthophyllitic zone parallels the contact and is often associated with uranium deposition. Minor amounts of uranophane and autunite were observed near the outcrop of the mineralized zone but have not persisted in appreciable amounts with depth. Over most of the explored area the zone of oxidation is shallow, and virtually all production has been in the form of uraninite and coffinite. Coffinite, a uranous hydroxysilicate only recently identified, possibly constitutes much of the black mineral previously assumed to be uraninite. Replacement of biotite by uraninite has been observed under the petrographic microscope. Pyrite and pyrrhotite are common associate minerals of the radioactive blacks, but both are also common in zones barren of uranium. The contact has been traced for approximately 2000 ft, disappearing to the south beneath the Spokane River and to the north beneath fluvial sands and gravels. Appreciable radioactivity is found along the total exposed length, but only the southern one-third has been explored to any degree. Here considerable stripping, with a small amount of exploratory drilling, has indicated a commercial deposit.

About 300 tons have been mined as a result of surface exploration. As further surface work is handicapped by a 60-ft capping of alluvium, an underground exploration program has recently been commenced.

Deposition in Tertiary Sediments: A few miles west of the previously described contact zone, a totally different and unexpected type of deposit was discovered in 1955. Here in an area of predominantly igneous and metamorphic rocks is a small body of indurated sediments containing a noteworthy deposit of uranium. The sediments are apparently the result of fluvial transportation and deposition of phyroclastics and residual fragments of granitic and metamorphic origin. Only a few hundred acres of this material have been revealed, and exploration indicates that the total deposit will not greatly exceed the present known limits. The underlying granitic rocks outcrop within a short distance to the

north, east, and south. Within a half mile to the west the Gerome andesite is exposed, and it is likely that the sediments could be classified as part of this formation. The extensive Camas basalt flows of Miocene age covering much of the area to the south are represented here by only a small erosional remnant.

Lithologically the sediments consist of a series of interbedded arkoses, conglomerates, and partially coalified plant remains, overlying an irregular erosional surface of the Loon Lake batholith. Study of plant remains has indicated that the formation is of Oligocene age. Tuffaceous and shaly facies have been noted but are not abundant. A persistent coarse conglomerate 10 to 25 ft thick occupies the lowest position in the sequence, and a similar but much more inconsistent bed often occurs as a capping, with observed thicknesses up to 40 ft. The contact of the sediments and the quartz-monzonite of the Loon Lake formation has a general northerly strike and dips about 10° to the west.

The ore zone appears to lie within a faulted block that is bounded on the west by a strong north-south fault and on the east by a less well defined parallel fault. These two structural features, which dip steeply to the west, are about 1000 ft apart. The north and south limits are more obscure, but the body is nearly equidimensional. Within these limits the total thickness of sediments ranges from 30 to possibly 100 ft. Although uranium minerals occur to some degree at various horizons, the ore zone generally lies immediately above the lower conglomerate, or approximately 20 ft above the granitic contact. Ore thicknesses up to 30 ft have been encountered. The mineralized west fault displaces the ore horizon, with the downthrown block to the west. Less is known of the east fault, but it seems to have been of similar displacement, with the intervening area a step fault block. Enough information has been obtained through drilling to indicate that the west fault is of the rotational or hinge type, with the hinge point lying south of the mineralized area. Displacement ranges from 60 ft on the south to 200 ft on the north of the explored area. Total thickness of the sediments west of this fault exceeds 300 ft. Drilling has indicated that the mineralized zone lying above the lower conglomerate exists on the downthrown side, and further drilling is planned to determine dimensions and grade.

The uranium minerals in this deposit are meta-autunite and uraninite, both occurring as interstitial fillings. In the surface cuts it is noticeable that the higher concentrations of uranium are usually associated with the carbonaceous beds. A certain amount of organic matter may be found throughout the sequence, and it is probable that the capacity of such material to adsorb or precipitate uranium is responsible for deposition. The source of the uranium is open to debate, as is the time relationship of faulting to deposition. The faults are subsequent to the deposition of the sediments, but whether they are post or pre-mineral has not been proved. The uranium may have entered in hydrothermal solutions ascending along faults, migrating outward, and depositing itself along favorable beds. On the other hand, ground water may have acted as the transporting agent. It is possible that both theories are in error and the uranium is of syngenetic origin. The genesis of uranium deposits is invariably controversial, and it is not possible to discuss in detail the evidence supporting the various theories.

Stripping and trenching, together with more than 11,000 ft of drilling, have blocked out an orebody exceeding 500,000 tons, according to published information. A large portion of the drilling has been financed by a DMEA loan. The reported average grade is in the neighborhood of 0.15 pct U_3O_8, which indicates that an upgrading system may be required to bring the lower grade portions of the deposit up to mill requirements. A study of such an upgrading process has been undertaken by Northwest Uranium Mines Inc., the operating company. No production has yet been realized from the property, as most of the work has been exploratory.

Mt. Spokane Area: A short distance west of Mt. Spokane is a uranium district that has seen a great deal of activity during the past two years. Uranium in this area of perhaps 100 sq miles is not difficult to find; in fact, its very abundance has perhaps handicapped orderly development of prospects into producing properties. Too often the limited amount of capital available for exploration will not permit complete evaluation of all of the uranium occurrences held by a single company; consequently each may get a token amount of work, and none are proved or disproved.

The Mt. Spokane district lies near the eastern limits of the Loon Lake granite and is entirely underlain by this formation. As usual, there is considerable regional and local variation in composition, but quartz-monzonite appears to be the predominant rock type. Pegmatitic segregations and dikes are common, comprising up to 50 pct of the rock locally. Kaolinization of the feldspars has resulted in considerable decomposition for 50 ft or more below surface. Some of the deeper alteration effects noted in drill cores are probably due to hydrothermal solutions rather than to weathering.

Deposition of uranium in the district is invariably controlled by faulting and fracturing, and degree of mineralization appears to vary directly with the intensity of such disruptive features. Much of the minor rock movement is undoubtedly a result of contraction or expansion of the igneous mass through rock alteration, as well as by erosional unloading. However, the more persistent faults and shear zones can be attributed to compressive forces and are characterized by low angles of dip.

Daybreak mine, the most extensively developed deposit in the area, is the source of most of the observations and conclusions presented here. On this property the most prominent structural feature is an east-striking shear zone dipping irregularly 8° to 25° north. This zone has been traced and exposed by trenching or stripping for more than 2000 ft on Daybreak's property alone. In some places total exposed thickness is at least 50 ft, although the footwall contact is gradational and difficult to establish precisely. The hanging wall contact is well defined by a bleached zone of fault gouge and breccia. A considerable percentage of the entire shear zone appears mylonitic, with individual grains of quartz and feldspar hardly distinguishable. A series of gash fractures originates at the shear zone and strikes northwest, with little evidence of movement. Striking northeast are a number of tension faults and parallel fractures, not as well developed as the northwest-trending structures. Horizontal displacement of the shear zone, as determined from these features together with drag effects at the hanging wall, indicates that the north block has been displaced west to east with respect to the south block.

To some degree uranium minerals may be found throughout the shear zone as well as in many of the transverse structures, but enrichment has obviously occurred at the intersection of the main shear zone and the northwest-striking fractures. The largest and richest orebodies have invariably been found at such intersections.

The Mt. Spokane deposits are unique in that uranium occurs as only one mineral species, meta-autunite. This mineral is common in the oxidized zones of many uranium deposits, but usually as an alteration product of uraninite, pitchblende, gummite, uranophane, or uranium-bearing columbates. No evidence of such alteration has been found here, and it is belived that the meta-autunite was emplaced as a primary mineral. Some dissolution and reprecipitation have apparently taken place, as evidenced by secondary growths of a fine-grained yellow variety of the mineral on massive, dark-green crystal aggregates. Some degree of solubility in ground water is indicated by numerous radioactive springs in the area.

The origin of the uranium-bearing solutions is debatable, and until deeper exploration has been accomplished the hypothesis of hydrothermal deposition will probably remain unproven. Drilling to date on the Daybreak mine has indicated uranium of commercial grade and thickness to depths of 95 ft below surface, or more than 100 ft downdip from the outcrop of the shear zone. Deeper drilling to determine maximum depth of ore zone has not yet been undertaken. It is not known whether appreciable amounts of uranium exist below the lower limits of a fluctuating water table, although some of the better drillholes encountered meta-autunite 50 ft below the apparent top of the saturated zone. The unusual thickness of many of the crystal aggregates, together with observed structural controls, indicates that uranium-bearing solutions probably originated at depth, traveling most easily along the shears and faults and impregnating adjacent fractures. Some localization of the uranium appears to have resulted from the damming effects of the kaolinite in faults and fractures. Massive aggregates of meta-autunite have been exposed in thicknesses up to 12 or 15 in. along the hanging wall of the main shear zone. Post-mineral movement is indicated by well developed slickensides on the mineral but this is believed to represent only minor adjustment, following the original displacement. Although pegmatites are common hosts of uranium, the segregations and dikes in this area were apparently barren at the time of their formation. Concentrations of meta-autunite, with a few exceptions, are no more evident in the pegmatitic facies than in the normal quartz-monzonite. Within the brecciated shear zone textural variations are so commonplace that the pegmatites in themselves are not considered worth mapping.

These characteristics of the Daybreak mine are typical of many nearby properties. Examinations indicate that uranium throughout the area occurs in very similar geologic environment. In almost every case the strongest shears or faults strike between west and northwest and dip at a low angle to the north. The next most prominent features are the minor faults or fractures striking northwest to north and usually dipping southwest. Many of the pegmatite dikes are oriented along these same planes of weakness and therefore may serve as guides during exploration. It is often possible to trace the shear zones by their control of topographic features, namely, stream channels which were originally cut into the more easily eroded rock of the shears and which now parallel the surface trace of these structures.

Most of the Mt. Spokane area has been explored only in spots and only on the surface. Much time and effort will be required before the area's potential is known. For lack of a local market few ore shipments have been made from the properties capable of production. Daybreak has shipped 6250 tons from two properties and has stockpiled during the past winter in anticipation of local milling facilities. North Star Uranium shipped two cars from a newly developed lease before suspending operations until spring. Several other companies continued exploratory work throughout the winter, but most efforts were curtailed pending the arrival of spring.

Minor Uranium Occurrences: The three types of uranium deposits described in this paper represent only those of known commercial value in northeastern Washington. Numerous finds of minor or undetermined value have been made throughout this part of the state. Probably the most common of these are the pegmatite dike deposits. Many reported discoveries of radioactive black minerals in the dikes have been verified, but generally these minerals are so sparsely distributed that mining the deposits is not feasible. In the oxidized zones various secondary minerals are found as alteration products of the primary blacks. Usually little effort has been made to identify the black minerals, although allanite and cleveite are known to exist in some of the deposits. The usual test has been merely to determine if the radioactivity were due to uranium or to thorium. Unfortunately a positive uranium reaction has frequently led to the assumption that the mineral was marketable, and considerable work has often been done on a property only to have subsequent amenability tests indicate that the minerals were refractory in existing processing plants. This situation has been true not only in the pegmatites but also in deposits occurring in the gneisses, schists, and related metamorphic rocks of northern Stevens and Ferry counties. As a result, development of even the best of the presently known deposits of refractory blacks is handicapped by the fact that should a body of commercial grade be discovered a profitable mining operation would be impossible. Methods of treatment could be developed if large reserves of sufficient grade were proved, but it is doubtful that expensive exploration and development programs could be conducted before such facilities exist.

Conclusion: The uranium industry in Washington is looking forward to a promising future as 1957 progresses. Development of known deposits is expected to proceed at a greatly accelerated rate now that a local market for the ore is imminent. For the same reason incentive to open up new deposits should be stimulated. Without prohibitive freight rates to cut profits, even deposits of barely commercial size and grade can be sufficiently rewarding to extend the life and activities of small companies. This will in turn permit additional exploration, development, and evaluation. As the more obvious deposits have already been located, future exploration will require deeper and more expensive methods. Every company, large or small, engaged in the search for uranium increases the possibility of adding to the reserves of the area.

Hauling Salt at Avery Island Mine

The sole means of gathering and transporting salt from the face area to the shaft, belt haulage has increased capacity from 1000 to 3000 tons per 8-hr shift.

by Erland Johnson

BRINE was discovered at Avery Island, La., in 1790, but it was not until 1862 that rock salt was found about 13 ft below surface—the first discovery of rock salt on the continent.

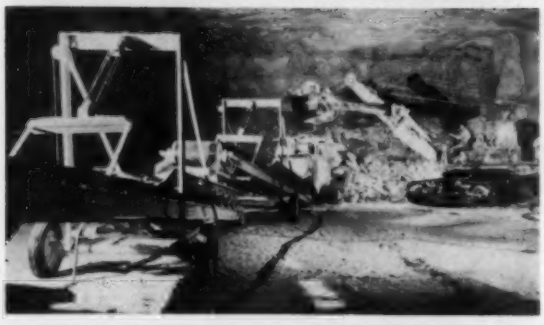
Maximum elevation of the island is 152 ft and elevation at the shaft 31 ft. The mining level is 530 ft below elevation at the shaft and the shallowest salt about 12 ft below surface. A shaft was sunk in 1869 when the mining operation started. In 1898 the present shaft was sunk, and the mine has been operated by International Salt Co. ever since.

In June 1955 the company finished modernizing and expanding the Avery Island mine. Completion of this program increased capacity from 1000 to 3000 tons in an 8-hr shift, at the same time reducing the mine working force by about one third. This was accomplished chiefly by installing belt haulage as the sole means of gathering and transporting salt from the face areas to the shaft.

In the planning stage a comprehensive study was made to determine the feasibility of adapting portable conveyors for the gathering system. Comparative cost estimates were prepared on operating and fixed charges for various haulage systems that differed only in the degree to which belt conveyors could be utilized.

The determining factor was the practicability of using a portable crusher at the working face. If

E. JOHNSON is Manager of the Avery Island Mine of International Salt Co. in Louisiana.



Series of underground operations at the Avery Island mine showing different phases of the operation. Higher unit productivity because of continuous loading and gathering as a result of the all-belt gathering and haulage system.

the size of the lumps could be reduced so that they could be handled on belt conveyors, without producing an excessive amount of fines, a portable crushing and hauling system would be possible. Choice finally centered on a Joy portable screw-feeder crusher originally developed by Freeport Sulphur Co. to crush lump sulfur to a size that could be handled on a belt conveyor. After many tests and alterations, all with the cooperation of Joy Mfg. Co., a crusher was developed that was sturdy enough to handle rock salt, which is much harder and tougher than sulfur.

During the preparation period of the mine improvement project, it was decided to use salt instead of sand and gravel for aggregate in the concrete needed for foundations and for tunnel walls under the storage pile. Instead of gravel, coarse salt was used and instead of sand, salt through an 18-mesh screen. These salts were mixed with cement and saturated brine in the same proportion as ordinary concrete used for this purpose. A number of cylinders were made up and tested for strength. After all the tests were completed it was found that this product, called *saltcrete*, had a strength 75 pct of ordinary concrete. Since it was no longer necessary to lower carloads of gravel and cement into the mine, construction costs were considerably reduced by substituting *saltcrete*, which was possible only because there was no exposure to weather.

The salt is mined by the room and pillar method. The working face, where the rock salt is shattered by explosives, is 100 ft across and 90 ft high and supporting pillars are 100 ft square. A Goodman shortwall mining machine is used to make a slot across the face at the bottom of the room. Equipped with an 11-ft cutter bar especially developed for salt cutting, this machine makes an average slot of 10 ft.

Drilling and Blasting: All drilling and blasting are carried out in two separate operations. Drilling is done by a caterpillar-mounted machine—designed by the company for this work—with four Scranton electric drills mounted so that they can swivel up and down or sidewise. One man operates two drills. Six horizontal rows of holes are drilled in the salt, 26 holes to a row. Each hole is loaded with du Pont Extra A-1 dynamite, and the charge is fired with du Pont millisecond delay blasting caps made with iron wire and aluminum shells. In processing the salt, magnets are used to remove the iron wire, a procedure very important to some users of salt. The remaining 66 ft of salt is drilled by an electric-powered crawler-mounted jumbo rig consisting of a two-piece telescopic mast. On the first mast, reaching from 24 to 50 ft, four Scranton electric drills are mounted in the same manner as on the drill machine previously described. Four more Scranton drills are mounted on the second mast, which reaches from 50 to 90 ft. Two drillers and one helper handle this operation. With delayed action caps, it is possible to blast the entire 66-ft high face at one time.

Originally developed and used in the Eagle-Picher mines in the Tri-State area, the high jumbo drill machine was redesigned by Landis Steel Co. of Picher, Okla., to fit International Salt Co. conditions.

All loading is done with caterpillar-mounted, electrically driven Marion shovels, which have a dipper capacity of ¾ to 1½ cu yd.

Primary Crushing at the Face: The Marion shovel loads the broken salt directly into the portable

screw-feeder crusher, which has a grill mounted in front of the discharge end to allow only —8-in. material to go through. To reduce power and also the amount of fines produced, the bottom of the crusher is a heavy cast steel grill with openings 6 in. square. A flight conveyor, which is an integral part of the crusher, removes and discharges the crushed salt onto a system of portable conveyors.

Haulage System: At present, portable conveyors 30 in. wide and 35 ft long, with a speed of 350 fpm, are used at the face areas for gathering and transporting salt from the screw-feeder crusher to the semi-portable conveyors.

All portable conveyors are furnished with Joy Limberoller idlers equipped with sealed roller bearings. More economical than a conventional three-roll steel idler, the Limberoller is suspended at each end, forming its own trough. It turns on its own axis and provides a simple and efficient support for the belt. The Limberoller weighs about half as much as a standard three-roll idler, and because it requires fewer bearings, friction is greatly reduced. It can be changed without stopping the belt conveyor and it is self-cleaning and corrosion-resistant.

Semi-Portable Conveyors: Thirty-inch semi-portable belt conveyors totaling about 1200 ft transport the salt from the portable conveyors to the main haulage belt. The semi-portable conveyors are made in 5-ft sections and have the same belt and idler specifications as the portable conveyors.

The sectional conveyor frames are supported by legs resting directly on the mine floor. The conveyors are readily extended or shortened by removing or adding sections.

At the discharge end of the main haulage belt, a powerful stationary magnet removes any iron particles or blasting wires from the salt.

Main Haulage Belt: From the semi-portable conveyor, salt is carried at 350 fpm to the 5x10-ft Tyler Ty-Rock grizzly screen by a 30-in., 650-ft belt conveyor equipped with conventional tapered roller bearings and all-welded steel roll idlers. The +2½-in. material is fed onto a 48-in. picking belt and then through a Jeffrey Flextooth crusher. The —2½-in. material screened out on the grizzly and the material passing through the crusher is then conveyed to a battery of three 5x12-ft Ty-Rock screens for preliminary separation. The +10-mesh material is further screened over four 4x10-ft Tyler Hummer screens. All —60-mesh salt is transported by belt conveyors and disposed of in abandoned parts of the mine and the +60-mesh salt is collected and conveyed to the 10,000-ton storage pile.

To provide adequate flexibility and reduce handling of salt from storage, a bypass conveyor was installed to carry all or part of the mine tonnage direct to the shaft.

An inclined 24-in. belt conveyor transports the salt at 475 fpm to a height of 50 ft over the mine floor to a shuttle conveyor, making it possible to discharge the salt at any desired point on the storage pile.

In a tunnel under the storage pile a traveling 24-in. belt feeder discharges salt onto a 24-in. belt conveyor, operating at 475 fpm, which carries the salt to a surge tank of 75-ton capacity. From this tank a 24-in. conveyor moves the salt to a skip-charging pocket of 20-ton capacity located in front of the hoisting shaft. The pocket is provided with two adjustable loading chutes, one for each shaft compartment, which are controlled and operated by the skips. Total length of all conveyors used in the mining operations is about 4550 ft.

Room and pillar methods are used. The working face is about 100 ft wide and 90 ft high. Supporting pillars are 100 ft square.

Power Distribution: To prevent overflow of surge tanks and costly production delays due to possible power failures, all machinery and equipment is provided with interlocking or sequence control. Limit switches in the surge tanks automatically stop and start the conveyors feeding salt to these tanks. All conveyors, screens, and feeders and the Jeffrey Flextooth crusher are interlocked by means of rotary switches, which are wired directly to the starters of the various units.

All transformer banks are provided with separate neutral grounding transformers. The grounding transformers, in conjunction with safety ground trips in the individual machine breakers, provide maximum protection for personnel and equipment.

The surge tank at the shaft; skip loading chutes; and 6-ton, bottom-dump discharge skips were furnished by Connelsville Mfg. Co.

After the salt is hoisted to the breaker, further crushing and screening separate the product into various grades, which are accumulated in bins for loading into cars, trucks, or barges.

Summary: The all-belt gathering and haulage system was selected for the following reasons:

1) Reduction in manpower needed to maintain design tonnage.

2) Reduction in repair-labor and repair-material cost in comparison with track haulage, combination truck and belt haulage, or any other system.

3) Higher unit productivity because of continuous loading and gathering.

4) Greater overall efficiency and operating economies.

Adoption of this program greatly reduced cost of salt per ton in bins. It improved service to customers by increasing capacity and by making it easier to meet surge demands.

Long Raises Save Money At Homestake

Costs per foot are higher, but miles of drifting are eliminated.

by C. N. Kravig

STANDARD raises at Homestake are 150 ft long. Raises of more than 150 ft, driven with the use of a cage and hoist, are considered long raises—some have been driven more than 900 ft. Long raises have eliminated the need for access drifts on each level when transfer and ventilation raises are driven.

These timbered cage raises, 7x9 ft in cross section, include a rock compartment and a combination cage, pipe, and manway compartment. To prevent excessive weight on the timbers, 10x10-in. bearing beams are cemented into hitches cut in the rock at 150-ft intervals. The beams also hold back timber movement caused by daily drawing of rock through the rock compartment.

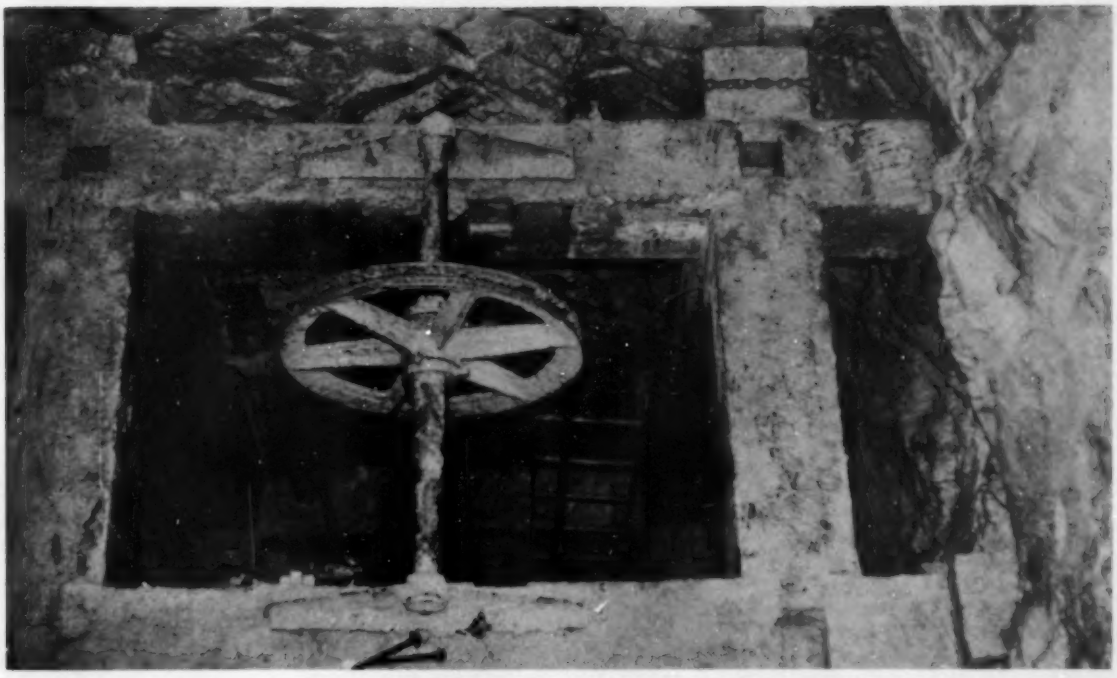
The cage used is very small—2 ft 4 in. square—and permits only two men to ride at one time. It is made with a flat bonnet so that raise timbers can be loaded on top and lashed to the hoisting rope. This brings the timber closer to the working face and cuts lifting by hand to a minimum. Timbers are lifted to the top of the cage by a single-drum hoist while the cage is standing on the floor. A safety door two sets above is closed to give protection to the man stationed on top of the cage while he detaches the tugger rope and lashes the timber to the hoisting rope. When hoisting timber, the cage is stopped about 7 ft below the sheave wheel, and the lashing to the hoisting rope is removed. The cage is then hoisted slowly until the rope clamps hit the sheave wheel. This places the top flush with the top of the raise timber, and the timber has to be lifted only a few inches and placed in the tenon holes.

Raisemen and hoist engineer generally communicate by a bell cord but can also use a telephone. These phones are cheap and flimsy but do a very good job. A pair cost about $24.00, and the wire adds about ½¢ per ft of raise.

A cycle of 7 ft each day is maintained with two men on day shift and two on night shift, not includ-

C. N. KRAVIG is Mine Superintendent, Homestake Mining Co., Lead, S. D.

Piece of timber shown at top is being hoisted to the top of this 2 ft 4 in. square cage. The cage is made with a flat bonnet so that raise timbers can be loaded on top and lashed to the hoisting rope.



A view looking down on raise timber and sheave wheel in 7x9 ft raise. Picture was taken from top of the ladder in the rock compartment.

ing the hoist operator. The night shift starts the cycle by drilling a round of about 38 holes with a seven-hole burn cut over the rock compartment. The blasting bulkhead is then installed and the air-water nozzle nailed into place and connected. About 24 tons of relief rock are drawn from the chute to leave room for a one-shot blast at the end of the night shift. A few millisecond delay electric caps are used in the burn cut and regular delay caps are used in the rest of the round in conjunction with a condenser discharge blasting machine.

The day shift men begin by running the empty cage up to the sheave wheel and back to the sill to dislodge any small rocks left hanging on the edge of the timbers after blasting. Meanwhile a mixture of compressed air and water from a nozzle under the bulkhead wets the pile and also ventilates the face and scales off small pieces of loose rock in the back. One man takes the cage to the top and checks as to whether his partner should pull more rock from the chute. After the necessary chute drawing is completed, one man crawls into the rock compartment through a 1-ft manhole left between the blasting bulkhead and the top of the timber. His job is to bar down loose rock and then to clean off the 21° inclined blasting bulkhead by shoveling into the rock compartment, where the bulkhead is later stored. As the chute is drawn, rock in the bin line is pulled down only far enough to hold the muck shoveled off the bulkhead and to provide storage room for the bulkhead material.

A gin pole is placed with one end on the top set of raise timber and the other resting against the side of the raise. The top end is forked to prevent turning. A small Budgit hoist suspended from the pole lifts the sheave wheel 7 ft to the top set of timber. The cage is either spotted on the sill or supported by chains, and the rope is allowed to slack off while lifting the sheave wheel. A set of 7-ft guides is installed, and the cage can then be hoisted to the top of the timber.

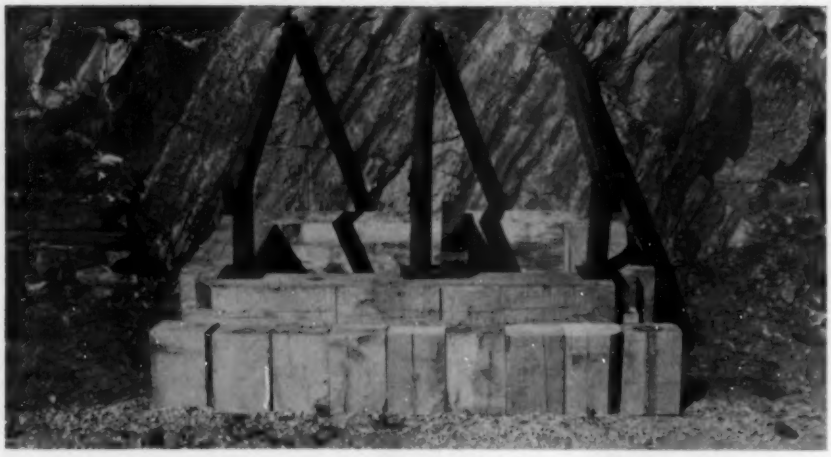
The 10x10-in. posts, caps and ties are now hoisted on top of the cage to the working face. The two men at the top of the raise unload the timbers by hand, place the posts in the tenon holes, and install caps and ties. The timber is then installed for lacing on the side of the rock compartment. Pinholes are drilled in the walls to accommodate 1-in. steel pins. Wedges driven between the pins and the timber keep the timber from moving toward the rock compartment. After the rock compartment is full of muck, the pins are no longer necessary.

From a platform installed just above the timber, pinholes are drilled in the wall of the rock compartment, level with the top of the raise timber. A plank is laid across these pins and other planks are laid from this plank across to the top of the raise timber.

Stopers and drill steel are then hoisted into position and made ready so the night shift can start drilling. The round is drilled with 94-lb stopers equipped with ⅞-in. hex drill rods and 1⅜-in. tungsten carbide bits. Special piping is needed to provide high pressure drilling water at the top of a 900-ft raise.

After the raise has holed through, the cleandown phase is done on a separate contract. Although most of the ground at Homestake is very firm, so that the raise can be cleaned and left untimbered, great care is taken to scale down any loose ground due to slips and fractures. Questionable ground is rock-bolted. A safety screen carried above the men during the cleandown operation is lowered by a tugger hoist as each set of raise timber is removed.

Except for the hoist operator's job, the entire work cycle is done on contract, both in the raising and cleandown operations. Price per foot of advance includes all necessary drilling, blasting, timbering, pipework, installation of guides, and raising the



Demonstration setup showing blasting bulkhead constructed out of special fabricated 40-lb rails with one end resting on the raise timber and the other end supported by pins inserted into holes in the rock.

sheave wheel. The contract includes barring, rock bolting, and removing timber.

Direct price paid to contractors for raising is $17.70 per ft, with an additional 50¢ per ft increase for each 100 ft of advance above the sill. The contractors pay for all explosives used. This compares with $11.93 per ft for standard 150-ft raises, which are driven without cage and hoist. Cleaning down is $2.80 per ft. Average dynamite consumption for 1956 was 13.87 lb of 45 pct Gelex No. 2 per ft of raise. Overall cost per foot of raise, which includes the day's pay hoist operator, installation and removal of hoists, timber and supplies, shop service, and maintenance and repairs, was $51.66 for 2400 ft of cage raises driven during 1956. Average advance per manshift was 1.73 ft.

The safety record in this type of raising is good. During the past two years there has been only one minor injury.

Owing to the flat pitch of the Homestake orebody, ore extensions in depth are generally explored by development crosscuts driven from a small prospect winze sunk near the orebody. When one of the main shafts must be deepened, a drift is driven from the prospect winze to the main operating shaft. A long raise, called a pilot raise, is then driven to meet the bottom of the main shaft, and the shaft is stripped to size and timbered. Cost of a pilot raise, plus stripping, is very much less than for straight shaft sinking. The price paid contract miners for a pilot raise plus the stripping and timbering of the Yates shift (15x27.5 ft) during 1955 was $67.58 per ft. The price for sinking and timbering the same shaft when it was deepened for sump purposes was $160.00 per ft, or 236 pct.

Two of the four access drifts have been completed for a new air shaft from surface to the 5000 level. To avoid the necessity for long access drifts on every level to reach the raise site, these four drifts will be followed by four long pilot raises, which will be stripped to size. Access drifts on every level would require some 29 miles of drifting, at a cost of $3 million. Without the long raises about 4000 ft of sinking would have been necessary.

Corrections

R. F. Hollis and C. K. McArthur, authors of "The Resin-in Pulp Method for Recovery of Uranium" (page 443, MINING ENGINEERING, April 1957), are pleased to acknowledge the contributions of the following persons in the development of the RIP process:

G. G. Marvin, Assistant Director, Division of Raw Materials, U. S. Atomic Energy Commission, who has actively supported and encouraged the activities of the Raw Materials Development Laboratory and its pilot plant. A. M. Gaudin, Richards Professor of Mineral Engineering, Massachusetts Institute of Technology, under whose direction the original process development was carried out. D. M. Kentro, Metallurgical Adviser, Division of Raw Materials, U. S. Atomic Energy Commission, and formerly Director, Raw Materials Development Laboratory, who encouraged development of the process in the original pilot plant. J. S. Breitenstein, Technical Director, Raw Materials Development Laboratory, under whose direction the new RIP installation was constructed, who has given continuing encouragement to the furtherance of the process on a commercial scale. The technical staff, past and present, of the Raw Materials Development Laboratory, whose test work provided the fundamental information which culminated in development of the process. D. R. George, A. M. Ross, and M. A. DeSesa, who provided technical assistance in preparing this paper.

On page 444 of the article the flowsheet figure should read: "Acid Leach—RIP Process" and under Discussion, page 449, item 2 should read: "Better than 99 pct recovery of the dissolved uranium values."

"Crestmore Makes a Change" by R. H. Wightman, P. B. Nalle, and C. D. Chandler (page 453, MINING ENGINEERING, April 1957). In the table entitled "Drilling Statistics for a 2-In. Hole" the main segregations should read "Footage and Tonnage" instead of "Footage and Costs." The figures represented are tonnage and not monetary figures.

The line beginning with Anaconda Chrome Co. (page 184, MINING ENGINEERING, February 1957) should read "American Chrome Co."

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James B. Morrow, retired vice president of Pittsburgh Consolidated Coal Co., is a native of Halifax, Nova Scotia. Winner of the 1955 Bituminous Coal Research Award, the AIME Erskine Ramsay Gold Medal in 1950, and the Percy Nicholls Award in 1944, he was Vice President and Director from 1953 to 1955. He also served the Institute as chairman, vice chairman, and member of the executive committee of the Coal Division. Mr. Morrow will serve as Vice President of the Society of Mining Engineers for one year.

James D. Forrester, Dean, College of Mines, University of Arizona, Tucson, will serve as Vice President of the Society of Mining Engineers for three years. Born in Salt Lake City, he obtained his M.S. and doctorate at Cornell and returned to his alma mater, the University of Utah, for the professional degree of geological engineer. Dean Forrester has been a geologist with Anaconda Copper Mining Co. and also worked for the U. S. Geological Survey. He has taught at Cornell and the Universities of Idaho, Missouri, Arizona, and Utah. He is the author of more than 40 technical papers and textbooks.

G. Donald Emigh, elected as Vice President of the Society of Mining Engineers for a two-year term, is a native of Idaho. After receiving his B.S. and M.S. degrees at the University of Idaho, he went on to obtain a doctorate in geology at the University of Arizona. Director of Mining at Monsanto Chemical Co., St. Louis, Mr. Emigh has been with the company since 1949, and since 1953, has been in charge of the Inorganic Div. Prior to joining Monsanto, he was associated with U. S. Vanadium Corp., a subsidiary of Union Carbide Corp. from 1937 to 1948. In the course of this 12-year period, he engaged in field work in the West and administrative duties in New York.

Raymond B. Ladoo, who is Treasurer of the Society of Mining Engineers, is a native of Ayer, Mass. A graduate of Harvard University, with an A.B. degree and one in mining engineering, he began his professional career with two Virginia companies, Low Moor Iron Co. and John B. Guernsey & Co. Inc. His varied activities in the minerals industry particularly qualify Mr. Ladoo for his present position as a consulting engineer in the industrial minerals field. Mr. Ladoo is the author of the book *Non-Metallic Minerals, Occurrence, Preparation, Utilization,* as well as numerous technical publications ranging in scope from the economics of the nonmetallic mineral industries to treatises on talc and fluorspar.

Solid Fuels Conference Slated for October

The 20th Annual Joint Solid Fuels Conference sponsored by AIME and ASME in cooperation with the CIM Coal Division, has been scheduled for Oct. 10-11, 1957, in Canada. Headquarters for the meeting will be the Chateau Frontenac in picturesque Quebec. This year the theme is the *Coal-Energy Reservoir of North America.*

Under the direction of program chairman H. B. Charmbury, the technical sessions are planned for Thursday and Friday, morning and afternoon. Among the papers tentatively scheduled are the following: *The Use of Solid Fuel in Production of Power; Dust Control for Continuous Mining; Flow of Coal in Bins; Pelletizing of Fine Coal; Calcination of Anthracite; Use Value of Competitive Fuels;* and *Transportation of Coal by Pipeline.*

H. B. CHARMBURY

Authors are reminded that the abstracts of all program papers must

(Continued on page 677)

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H. R. Gault—Geology
H. L. Scharon—Geophysics
J. A. Hagy—Coal Div.
D. R. Mitchell—Coal Div.
S. D. Michaelson—MBD
N. L. Weiss—MBD
R. C. Stephenson—IndMD
G. H. Chambers—IndMD

Tampa Meeting Schedules Phosphate Trip

One of the field trips planned for the first Annual Meeting of the Society of Mining Engineers is a tour of the Noralyn phosphate mine, above, of International Minerals & Chemical Co. A remote control hydraulic gun is seen in the foreground. This fall meeting is slated for October 15 to 18 at the Hillsboro and Tampa Terrace Hotels, Tampa, Fla.

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ROCK IN THE BOX

News of M.G.G. Division

MGG Chairman Introduces Newsletter Planned As Regular Magazine Feature

The MGG Division is composed of AIME members whose major professional interests are mining, geology or geophysics. As you pay your dues each year you are asked to check the areas of greatest professional interest to you, and through this selection you become a member of one of the new AIME Societies (Mining, Metals, or Petroleum.) In addition, you may become a member of a Division, such as the MGG, within a Society.

There are approximately 10,600 members of the Society of Mining Engineers, and 4,000 have specifically indicated interest in MGG. An additional 2,400 AIME members would probably be in MGG if they had expressed any divisional affiliation. We doubt that even 10 pct of our membership knows of this affiliation. Many of those who are familiar with MGG may not understand its functions. We hope through this page to bring about a better understanding of our purposes and activities.

MGG was established to provide cooperation between those engaged in the three technologies, particularly by holding meetings where papers of interest to the group are presented. This is accomplished on a national scale rather than through local Sections, and those who have attended the February Annual Meetings of AIME are familiar with the programs presented by MGG. The division also has Membership and Publication Committees working on both a national and local Section basis. You will hear more in future issues of *Rock in the Box*.

For your information, the MGG Division is in the process of rewriting its own Bylaws to promote even better cooperation between miners, geologists and geophysicists, and we are inviting geochemists to join our group. This reorganization will be discussed in detail in future letters.

New officers for MGG are installed each February at the Annual Meeting, and in this letter we wish to introduce the men responsible for activities in 1957. MGG has a Chairman, three Vice-Chairmen (one each for mining, geology and geophysics) and a Secretary. Through these columns we will introduce other Committee personnel during the year. Information regarding MGG Division members and activities will be appreciated, together with any questions you would like answered. Please send your letters to the MGG Division Secretary, Glen A. Burt, 815 Kearns Bldg., Salt Lake City, Utah.

—Clark L. Wilson
Chairman, MGG Division

YOUR DIVISION OFFICERS

C. L. WILSON

R. HOLMER

E. H. WISSER

H. C. WEED

G. A. BURT

MGGD Chairman—Clark E. Wilson is a graduate of the University of Utah, and received his M.S. Degree in geology from the University of Arizona. Formerly national program chairman, Mining Subdivision, he has also served on the Institute's Nominating Committee, and in 1953 was Utah Section chairman. Mr. Wilson is vice president and director of New Park Mining Co. and Northwest Uranium Mines Inc., in addition to serving as director of East Utah Mining Co. and Treasure Uranium & Resources Inc. He is president and director of the Utah Mining Assn., and vice chairman, Salt Lake Committee, American Mining Congress.

Vice chairman—Geophysics—Ralph C. Holmer was born in Chicago and attended the Colorado School of Mines where he received a geological engineering degree in 1939 and a doctorate in geophysics in 1954. Prior to joining Bear Creek Mining Co. as chief geophysicist in 1952, Mr. Holmer taught at the Colorado School of Mines. An active member of the Society of Exploration Geophysicists, he is serving as the first chairman of the Committee on Mining Geophysics.

Vice chairman—Geology—Edward H. Wisser's career has taken him to Mexico and the Philippines, as well as many western states. A graduate of the College of Mining, University of California, he has been teaching there since 1947, and is now Professor of Mineral Exploration. From 1926 to 1936 Mr. Wisser did exploration in Mexico for several companies, and since 1955 he has been a partner in the firm of Wisser & Cox, consulting geologists, in San Francisco.

Vice chairman—Mining Subdivision—H. C. Weed, a native of Michigan, graduated from Michigan College of Mines. After a short stint as efficiency engineer and miner for Calumet & Hecla Mining Co., he joined United Verde Copper Co. in Jerome, Ariz. Since 1937 he has been associated with Inspiration Consolidated Copper Co. in Inspiration, Ariz., beginning as shift boss, and eventually becoming assistant general manager.

MGGD Secretary—Glen A. Burt, another University of Utah alumnus, is currently assistant to the manager, Tooele Plant Operations, International Smelting & Refining Co. in Salt Lake City. He was promoted to this position from the post of senior ore buyer, Ore Purchasing and Metallurgical Departments of the company. A vice chairman of the AIME Utah Section, Mr. Burt had served as secretary of the Mining Subdivision of MGG. He is also a member of the advisory council, State Dept. of Employment Security.

Reno Host to Mineral Industry Conference

Acting Mayor of Reno, left, presents the Key to the City to AIME President Grover J. Holt, as Sidney J. McCarroll, chairman of the Nevada Section sponsoring the conference, center looks on.

During the field trip to Eagle-Picher, a visitor observes the Cat D-8's ripper attachment, in use at the company's diatomite operations south of Reno. Another view of the operation is shown below.

Before beginning their tour of Eagle-Picher Co., guests are briefed about the company's operations.

The Pacific Southwest Mineral Industry Conference held in Reno, April 5 and 6, was honored by the presence of AIME President Grover J. Holt. This regional meeting of AIME's Nevada, San Francisco and Southern California Sections, had a record turnout of 407, in addition to the 150 ladies who attended.

Presiding at the welcoming luncheon, Friday, April 5, in the Mapes Hotel, was Sidney J. McCarroll, chairman of the Nevada Section. More than 300 were present to hear the featured speaker, George A. Kiersch, Southern Pacific Co., who discussed *Geological Investigations —Applications in Developing the Mineral Resources of a Region.*

That evening the cocktail party and dinner were held in the Riverside Hotel. With Vernon E. Scheid, general chairman of the conference presiding, student awards were presented and the various dignitaries introduced.

The Annual Essay Contest is open to all undergraduate students at the Mackay School of Mines, and the papers must be related to the mineral industry.

First prize of a Polaroid camera was awarded to Lewis S. Lohr, student from Hollywood, Calif., for his paper entitled, *A New Mississippian Spiriferoid Brachiopod.* Second prize, a Brunton compass, went to Maxwell Botz, from San Francisco, for his paper on *Geology of a Portion of the Antelope Range, Nevada.* Paul Hauser, the only freshman contestant, won honorable mention for his paper on *Ore Deposits in the Whipple Mountains Region, San Bernardino County, California.* The prizes were contributed by Titanium Metals Corp. of America and were awarded to the winners by Frank Love, process engineer of that company.

There were simultaneous technical sessions on geology and mining on Friday morning. Among the papers featured in the geology session were: the role of phosphate in the economy of the Pacific basin; scheelite at Grass Valley, Calif.; major mineral belts in Nevada; photogrammetric mapping, and portable vacuum circulation exploration. Charles F. Park, Jr., and David B. Slemmons were co-chairmen.

Those present at the mining meeting, led by T. R. Graham and M. L. Leonardi, heard papers on blast hole methods; developing a new open pit mine; use of steel castings in mining equipment; and the plans for metallurgical and industrial plants.

In the afternoon session on industrial minerals, five papers were read: *Development of Ione Super Duty Fire Clay; Occurrence and Mining of Crystalline Magnesite at Gabbs, Nev.; Mineral Resources of the Ione Formation, Calif.; Nevada Gypsum and Its Economic Future;* and *Commercial Aspects of Nevada Barite.* Lauren A. Wright and Royce A. Hardy were co-chairmen.

The session on metallurgy, held at the same time, was led by Kellog Krebs and F. A. Lawrence. Featured were papers on the operation of liquid cyclones at Calaveras Cement Co.; application of heavy media process on concrete aggregate; Anaconda's fluosolids and acid plant; agglomeration flotation of manganese ore; and commercial methods of processing lithium ores.

Field Trips

The field trips proved most successful; more than 120 visited Anaconda Co.'s Weed Heights operation where they saw the open pit, acid plant and leaching plant. Luncheon was served under the direction of A. E. Millar, general manager of the operation. The return trip was made by way of Virginia City, with stops at the Smokery, Delta and Bucket of Blood (western style soda fountains).

The alternate choice was a tour of the diatomite operations of Eagle-Picher Co. in Clark Station, Nev., and to the fluorspar mill of Kaiser Aluminum & Chemical Corp. in Fallon, Nev. The tour was made via picturesque Truckee Canyon, returning through Virginia City.

On Friday the female contingent enjoyed a special Smorgasbord Luncheon at the Mapes Hotel, after which they visited the University of Nevada and the Mackay School of Mines. Saturday morning their sightseeing trip included stops in Virginia City, and Comstock Lode.

Fuels Conference

(Continued from page 673)

reach the AIME in New York by July 1, 1957.

Called the City of Remembrance, Quebec abounds with historic sites, quaint buildings, and narrow streets that impart an old World atmosphere, particularly a French flavor. Art lovers will be delighted with the exhibits in the Provincial Museum, and the Laval University collections. Founded in 1534, Quebec is the only walled city in North America.

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PAYMENT MUST ACCOMPANY ORDER

After a smooth flight to Portland, AIME President-Elect Augustus B. Kinzel, center, chats with Field Secretary Roy E. O'Brien, left, and Don W. Johnson, general chairman of the conference.

Pacific Northwest Regional Conference Scores With Superior Technical Sessions, Outstanding Speakers, Interesting Field Trips

The staff of the USBM Experimental Station in Albany, Ore., is shown welcoming conference visitors on their arrival from Portland for an all-day tour of the activities at the Bureau Station, the Oregon Metallurgical Corp., and the Wah Chang Corp.

A bevy of top-flight engineers including President-Elect Augustus B. Kinzel, convened in Portland, Ore., April 11 to 13 for AIME's three-day Pacific Northwest Regional Conference. More than 200 persons representing Oregon, Washington, Idaho, Wyoming, Montana, British Colombia and Northern California, signed the registration book at the Multnomah Hotel. Included in the group were about 30 wives.

On the opening day, Thursday, delegates chose between two tours, one to the Oregon Metallurgical Corp., the Wah Chang Corp., and the USBM at Albany, Ore., with a luncheon stopover in Corvalis, where the guest speaker was W. J. Kroll, metallurgical consultant. Dr. Kroll has won numerous awards for his contributions to metallurgy, and is credited with the discovery of ductile titanium.

The alternate Thursday tour was to Portland's new multi-million dollar glass container operation, the Owens-Illinois Glass plant.

Relaxing between sessions in the Multnomah Hotel are George Beard, left, guest speaker at the Friday luncheon, and R. R. McNaughton, who gave the keynote address Saturday at noon.

In this scene taken at the banquet on Friday, President-Elect Augustus B. Kinzel is shown addressing the guests. Seated left to right: D. W. Johnson, R. E. O'Brien, and T. E. Kesler.

On the tour of USBM Experimental Station in Albany, Ore., Charles C. Nolan stops to examine the display of a valve coated with titanium metal.

Two outstanding luncheon speakers were heard Friday and Saturday. George Beard, assistant vice president, Pacific Power & Light Co., addressed the luncheon guests on Friday. His topic was *Possible Effect of Coal Utilization on Northwest Power Production.*

Speaker for the Saturday luncheon was R. R. McNaughton, metallurgical manager for Consolidated Mining & Smelting in Trail, B. C.

Dr. Kinzel, the featured speaker at the Friday night banquet, discussed *Research and the New Metallurgy.* He has lectured throughout the world.

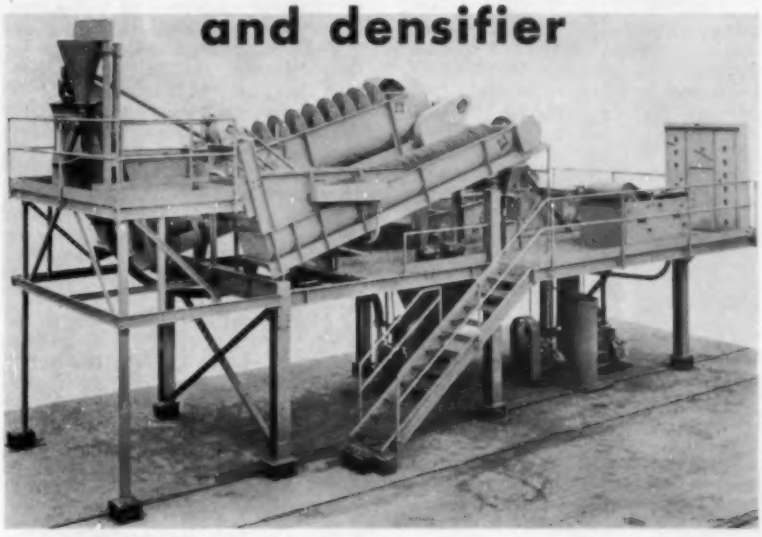
Two days of the conference were devoted to technical sessions covering geology, extractive metallurgy, industrial minerals, iron and steel, minerals beneficiation and physical metallurgy.

Among the outstanding papers presented were: *Riddle Nickel Deposit* by W. A. Foster, Hannah Coal & Ore Corp.; *Chemical Requirements of the Western Mineral Processing Industry* by Raymond E. Byler of Arthur D. Little Inc.; *Alloys 5086 and 5083* by M. C. Fetzer, Kaiser Aluminum and Chemical Corp.; *Streaming Potential in Flotation* by D. W. McGlashan, Montana School of Mines. Professor McGlashan gave a second outstanding paper, *Rheological Consideration of Manganese Oxide Ores.*

During the conference the ladies were entertained with a morning coffee hour, and a luncheon and fashion show in the Rose Bowl.

Much of the success of this conference can be attributed to the work of the following: Donald W. Johnson, general chairman; technical sessions chairmen, Hollis Dole and Fay Libbey, Geology; Pierre Hines and Emmons Coleman, MBD; Ralph Mason and Chester Kershaw, IndMD; and John Anderson, Francis Cappa, Vincent Belusko, Donald Ingvolstad, Haruo Kato, Metals; Edward Vistica, general arrangements chairman; and John Yeasley, field trips.

Prefabricated HMS plants with AKINS separator and densifier



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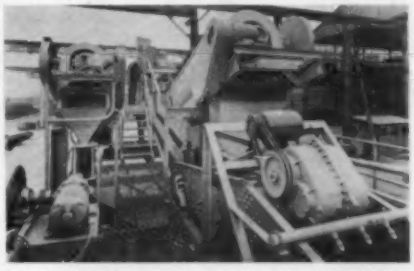

Media discharge end of Akins Densifier showing demagnetizing coil.

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Around the Sections

• The **Boston Section** met on March 4, at the MIT Faculty Club in Cambridge, Mass. The dinner-meeting was a traditional honor to Professor Richards who contributed so much to the development of mineral engineering. Guest speaker for the occasion was A. M. Gaudin who occupies the Richards Chair of Mineral Engineering at MIT. He is also the author of a book on flotation which is now a standard text. Prof. Gaudin's topic was *Native Flotability and Crystal Structure*. Dr. Gaudin is the 1957 winner of AIME's Robert H. Richards award.

• The **Spokane Subsection** of the Columbia Section held a joint meeting with the ASME on Feb. 27, 1957, in the Gonzaga University Engineering Building. Highlight of the meeting was the talk by B. H. Jones on open pit copper mining in Utah. Mr. Jones, who is an electrical engineer for Kaiser Aluminum and Chemical Corp., illustrated his lecture with colored slides.

• The Annual Meeting of the **Colorado Plateau Section** was held on Saturday, March 9, in Grand Junction. The technical sessions and business meetings took place in the Civic Auditorium while the La Court Hotel was the scene of the cocktail party, dinner and informal dance in the evening.

The technical program was varied and included the paper, *Slurry Pipeline as an Integral Link in Gilsonite Refining Project*, by Lee Morris and John Henderson. This was followed by a movie and discussion on Continental Uranium Co.'s open pit operations by John Rosco and Herb Reynolds. Concluding the program was a sound film *Mining For Nickel*, which describes Inco's Canadian operations.

• The **Oregon Section** meeting on February 15, took place in the Burns Restaurant, with chairman Lloyd H. Banning presiding. Highlight of the program was a screening of the new Reynolds color film, *Aluminum on the March*, which was introduced by Don Johnson. Earlier, in the business meeting, the Section approved the annual donation to the Portland Library for the purchase of technical books.

The Section met again on March 15, to hear Fayette I. Bristol, manager, Bristol Silica Co., Rogue River, Ore. A member of the House of Representatives, he discussed the effect of the new state tax laws on mining and industry.

Officers of the student chapter at Oregon State College, in Corvallis, are: president, Ludwig Hartung; vice president, Stan Pereira; secretary-treasurer, Gary Carnahan. At the University of Oregon chapter John Fryberger is president; Norman Peterson, vice president; Robert Dale, secretary; and Don Stanley, treasurer.

• The **Ajo Ariz. Subsection** held its regular monthly meeting on February 14, at the Copper Coffee Shop. Chairman W. C. Hunter introduced two guests: Thomas E. Diehl and Frank Galloway, both of the New Cornelia Branch, Phelps Dodge Corp. After dinner, members were shown a film, *This is Mi Vida*. Produced by Utex Exploration Co., Moab, Utah, the movie answered many questions on uranium mining operations on the Colorado Plateau.

The Section met again on March 14, at which time they heard John O'Neill, Phelps Dodge Corp., who presented a paper on the geology of the New Cornelia Open Pit Mine.

• The **Washington, D. C., Section** met on March 9, at the Cosmos Club for cocktails and dinner. Guest speaker was Samuel Epstein, technical adviser to the research department, Bethlehem Steel Co., Bethlehem. Mr. Epstein discussed recent advances in the metallurgy of steel.

Wives of Section members are invited to join the Woman's Auxiliary which holds a luncheon and meeting the second Tuesday of each month at the Broadmoor Hotel.

• At the **Colorado MBD Subsection** get-together at the Studio Restaurant in Denver on February 9, during the Colorado Mining Assn. Convention, members enjoyed a real ranch-type breakfast.

The Annual MBD Pike's Peak Subsection meeting was scheduled for May 11, at the Broadmoor Hotel in Colorado Springs. An interesting technical program was presented at that time.

• The **St. Louis Section** meeting on March 8, was held on the campus of the Missouri School of Mines & Metallurgy, Rolla, Mo. The school and the USBM held open house.

Featured speaker at the dinner was F. Rolf Morral, Battelle Memorial Institute, who addressed the Section on the subject of *The Production and Uses of Cobalt*. Dr. Morral illustrated his talk with a sound film in color *Cobalt in Katanga*. Members of the WAAIME also attended the dinner and evening program.

• The **San Francisco Section** held a dinner-dance with the Ladies' Auxiliary in the Terrace Room of the Fairmont Hotel on March 23. Entertainment chairman Fred Lohse engaged Rod McCauley's orchestra and other top flight entertainers who provided a good time for members and guests.

On the Move, **a new 16-mm color sound film, which runs 28 min, is now ready for showing. The film deals with the subject of transportation and points out the important role played by road building equipment. The St. Lawrence Seaway project, material handling, and general turnpike construction are covered. The human interest plot offers the story of a student engineer who is confronted with a career decision. A limited number of copies are available from the producers, Baldwin-Lima-Hamilton Corp., Advertising Dept., Lima, Ohio.**

A film entitled *News From the Coal Country* **is available for free loan distribution from Modern Talking Picture Service Inc., 3 E. 54th St., New York 22, N. Y. Produced by the North American Coal Corp., the film can be obtained only in the following states: Illinois, Michigan, Minnesota, New York, North Carolina, Ohio, Virginia, West Virginia, and Wisconsin.**

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Abstracts Due For 1958 Nuclear Congress

Industrializing the Atom will be the theme for the 1958 Nuclear Congress now definitely set for March 17 through 21 at Chicago's International Amphitheater. With plans well underway, sessions are scheduled to cover economics, finance, future plans, and much more.

All engineers and scientists working in the nuclear field are urged to contribute one or more papers. There were 158 papers from all aspects of nuclear science and engineering at the 1957 Congress in Philadelphia. Abstracts are due by July 15, 1957, and AIME authors should get in touch immediately with Frank A. Rough, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio. All papers are being handled by individual societies and not by Engineers Joint Council. Co-ordinated by EJC, for its member societies, managed by American Institute of Chemical Engineers and sponsored by the engineering and scientific societies interested in the nuclear field, the 1958 Congress promises to be bigger than ever. Once again the Hot Laboratories and Equipment Conference, and the National Industrial Conference Board's Atomic Energy in Industry Conference will be a part of the 1958 Nuclear Congress.

A major part of the Nuclear Congress will again be the International Atomic Exposition where engineers, scientists and management men can see and discuss with industrial representatives, all nuclear processes and materials currently available. At Philadelphia in 1957, a total of 16,429 engineers, managers and scientists attended the Exposition. With the advances a year can bring to the rapidly growing industry, the 1958 Exposition should attract many more.

Under the leadership of John R. Dunning, chairman of the Nuclear Congress Policy Board, Bruce R. Prentice, chairman of the General Committee, and John W. Landis, chairman of the NESC Conference Committee, the 1958 Nuclear Congress is expected to mirror all the advances of the nuclear field. Authors are again urged to submit their proposed papers to their societies as soon as possible.

Pennsylvania-Anthracite Section Spring Meeting

The **Pennsylvania-Anthracite Section** met at Genetti's Restaurant in Hazelton, Pa., on Friday evening, April 26, with chairman Floyd S. Sanders presiding. A cocktail party sponsored by the stripping contractors, preceded the dinner. The party and dinner attracted more than 300 members and guests.

Mr. Sanders discussed events of interest at the recent Annual Meeting in New Orleans, and reported on the changes in Branch-Society structure. Then he introduced Arnold Buzzalini, Secretary of the Society of Mining Engineers of AIME, who announced the forthcoming fall meetings in Quebec and Tampa, Fla., and extended greetings from Elmer A. Jones, Society President.

Theme of the meeting was blasting problems in the anthracite industry. The technical program under the direction of William Butler, featured the following papers: *Modern Drilling Equipment and Practices* by Julian Parton; and *Reduction of Vibration Complaints from Blasting* by Robert Klotz. Both papers stimulated interest, and a lively discussion and question and answer period developed. Before the meeting was adjourned at 11 pm, Chairman Sanders announced that the annual summer get-together, would be held in June when the Section would entertain AIME President Grover Holt and Secretary E. Kirkendall.

Clay Conference Set For August in California

The Sixth National Clay Conference will be held at the University of California in Berkeley, August 19-23, for those interested in studies of clay minerals and technology.

Included in the five-day program is a field trip to major clay deposits in the area. Sessions will be devoted to clay genesis, fundamental characteristics and behavior of clay-liquid systems, and to subjects of general interest. Panel discussions and question-and-answer periods are also scheduled.

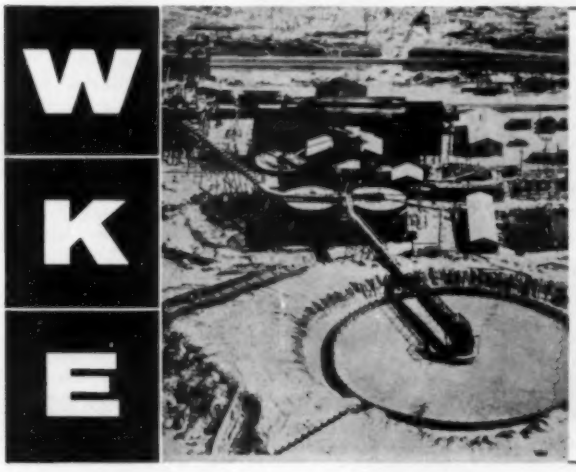
The conference is sponsored by the University's College of Engineering, in cooperation with the Clay Minerals Committee, National Academy of Sciences, National Research Council.

Further information may be obtained from Dept. of Conferences and Special Activities, University of California Extension, Berkeley, Calif.

New AIME Delegate For ESPS in San Francisco

The San Francisco Advisory Committee of the Engineering Societies Personnel Service, presented a Certificate of Award to Herbert A. Sawin, for his work in the field of personnel placement. Mr. Sawin, of Yuba Manufacturing Co., retired as AIME representative to ESPS, after more than 30 years of service.

L. A. Norman, Jr., has been appointed by Rodgers Peale, AIME San Francisco Section chairman, to represent the Institute on the committee. Mr. Norman, staff engineer for Equipment Engineers Inc. has been a member of AIME since 1935.



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PERSONALS

C. E. WEED

Clyde E. Weed, president of The Anaconda Co., was honored recently by Chile, which made him a Knight Commander of the Order of Merit of Bernardo O'Higgins. The award was in recognition of his company's cooperative attitude toward the Chilean government.

Sheldon L. Glover has retired as supervisor of the Washington State Div. of Mines and Geology. His professional geological career covers 40 years and includes 12 years with the division. Prior to this association, he had served as supervisor for the Div. of Mines and Mining from 1941 to 1945, and was assistant supervisor of the former Div. of Geology from 1934 to 1941. **Marshall T. Huntting** has been appointed his successor. Mr. Huntting has been on the staff of the division and its predecessor agency, the Div. of Geology, since 1941. For the past two years he has served as assistant supervisor.

Philip C. Hewitt has resigned his teaching position at Cornell University to join the geology department of Union College, Schenectady.

Philip D. Wilson, a prominent New York mining consultant, was recently elected president of Pinnacle Exploration Inc., subsidiary of Callahan Zinc-Lead Co. and Vulcan Silver-Lead Corp., Gunnison, Colo. **James E. Dunn** is serving as manager of the new company.

P. V. G. Ford has returned to England from Egypt, where he had been serving as general manager and managing director of the Sinai Mining Co. Ltd. for seven years. Prior to his appointment in Egypt, Mr. Ford had worked for many years in Chile and Bolivia.

Parke A. Hodges, vice president of Behre Dolbear & Co. Inc., N. Y., has been doing professional work in Liberia and Sweden.

On page 587 of the May issue, the picture labelled W. H. Aldridge was miscaptioned. It should have read W. H. Aldridge.

L. A. Patterson has joined the Gatis Rubber Co., Houston.

A. A. Bakewell, Jr., former project engineer of Deep Ruth mine, Nevada Mines Div., Kennecott Copper Corp., is with the Baguio Gold Mining Co., Baguio, P. I.

Ira B. Joralemon, a director of AIME in 1941, has been elected to the board of directors of the Bunker Hill Co. A mining consultant and geologist since 1923, Mr. Joralemon is also a director of the Copper Range Co., Homestake Mining Co., and is president of Summit King Mines Ltd., a subsidiary of Bralorne Mining Co. Author of a book, *Romantic Copper,* he has lectured on mining and geological subjects in universities throughout the U. S.

Robert M. Haldeman, general manager, Braden Copper Co., Santiago, Chile, has been promoted to vice president. He has been with the company, a subsidiary of Kennecott Copper Corp., since 1941.

Peter G. Braham, formerly of Western Mining Corp. Ltd., is manager of Ravensthorpe Copper Mine, Ravensthorpe, Australia.

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J. V. THOMPSON

James V. Thompson, mining development engineer of Denver, has joined Kaiser Engineers at Oakland, Calif. Formerly associated with Humphreys Investment Corp., Denver, he began his career in the mining and milling operations of the Baguio Gold Co., P. I., and was later with the Dorr Co.

W. P. Gillingham has resigned as mine engineer for the Potash Co. of America Ltd., Sask., Canada, to take a position as mine superintendent, National Lead Co., Baxter Springs, Kan.

Kevin M. W. Marshall, who recently graduated from St. Francis Xavier University, Antigonish, N. S., Canada, is employed as geologist, Dominion Oil Ltd., Trinidad, B. W. I.

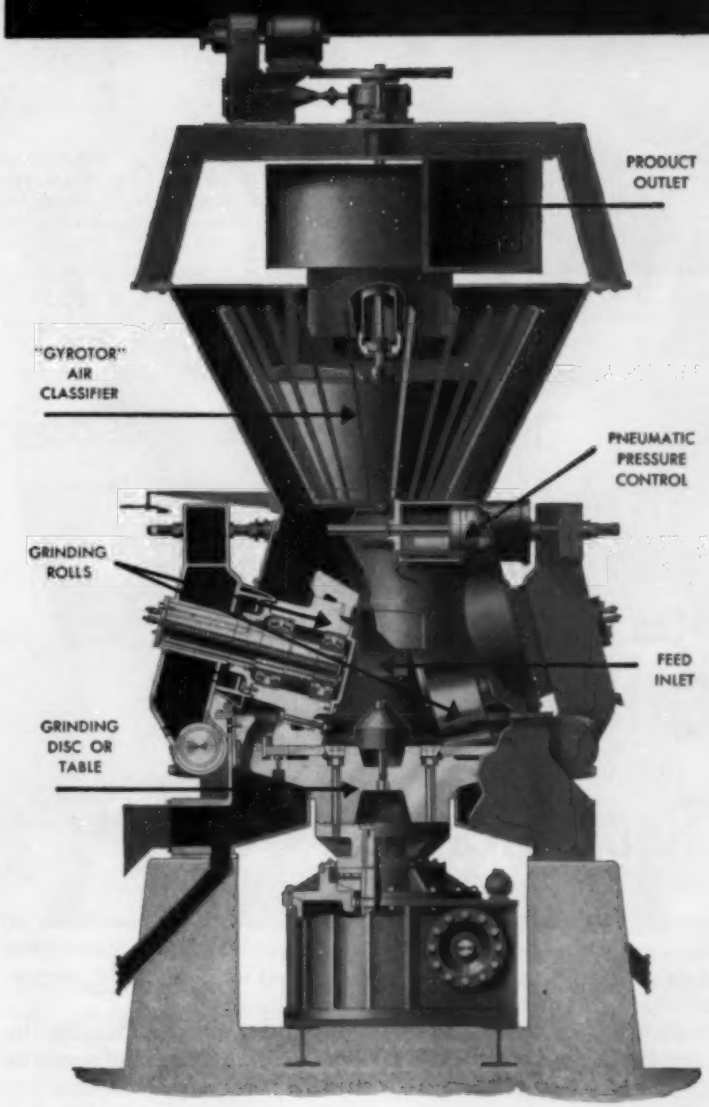
R. C. DIEHL

Richard C. Diehl has resigned as president of the Chase Brass & Copper Co., Waterbury, Conn., a subsidiary of Kennecott Copper Corp. A director and past-president of the Copper & Brass Research Assn., Mr. Diehl was formerly associated with Wheeling Steel Corp.

James R. Perrin, Jr. has transferred from the Silver Bell, Ariz., unit of American Smelting & Refining Co. to the Keystone Unit, Crested Butte, Colo.

Lou D. Jordan has joined Gibraltar Mining Co., Hachita, N. M.

DISC-ROLL MILL



The Hardinge Disc-Roll Mill is a roller-type mill with two adjustable, pneumatically loaded rolls for grinding material on a horizontal rotating disc or table (Loesche type). The Hardinge "Gyrotor" Air Classifier, in combination with the mill, provides a complete grinding, classifying, and drying system. A full description is given in Bulletin 52-2.

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F. A. LINFORTH

F. A. Linforth, a past-president of the AIME Montana Section, has retired from The Anaconda Co., where he was assistant to the vice president. He has devoted more than 50 years to the company. A native of Butte, Mr. Linforth graduated from the University of California in 1906 with a degree in mining engineering. He had been in charge of the geological, sampling and mining engineering departments prior to his appointment as assistant to the vice president in 1947.

Warren L. Howes has resigned as manager, Western-Knapp Engineering Co., San Francisco, to set up his own consulting practice in Menlo Park, Calif.

E. H. Rose has resigned his post with the National Research Council's Materials Advisory Board to join the staff of Koppers Co. Inc., Pittsburgh.

A. B. WALTERS

A. B. Walters, chief engineer in the Belting Dept., Coal Div., Goodyear Tire & Rubber Co., recently received an award commemorating his 25 years of service with the company. A pioneer of modern belt conveyor methods in mines, he joined Goodyear in 1932.

John W. Svanholm, consulting economic geologist for the government of Burma, has accepted a contract renewal for another 2-year term. He conducts exploration for tin, tungsten, iron, zinc, monazite and uranium.

Joseph E. Ward has been named assistant manager, Pittsburgh Coal Sales, Joy Manufacturing Co. Prior to joining Joy, he had been division sales manager, National Mines Service Co., and was employed for 15 years as underground supervisory official for the Tennessee Coal, Iron & R. R. Co., a subsidiary of U. S. Steel Corp. in Fairfield, Ala.

Herbert H. Kessler, mining engineer at Allis-Chalmers Mfg. Co., Philadelphia, has retired after 22 years with the company.

Dionys Burger has resigned from Australasian Oil Exploration Ltd. to accept a position on the geological staff, The Broken Hill Proprietary Co. Ltd., Whyalla, South Australia.

Donald H. Bailey has resigned his position as mines geologist, International Nickel Co. of Canada Ltd. to become a research engineer, the Ruberoid Co., Hyde Park, Vt.

Robert M. Miller, formerly mine manager at Minas-Industrias S. A., Asuncion, Paraguay, has joined Frontino Gold Mines in Colombia.

Dale E. Hirschfeld is sales engineer, Jeffrey Manufacturing Co., Columbus, Ohio.

Eiichi Nomura has accepted a position as chief of the planning board, Nippon Mining Co. Ltd., Tokyo, Japan.

Carlos M. de Armas is no longer with Minera Occidental Bosch, S. A., Pinar del Río, Cuba. He has joined Iberia Machinery Co., Havana.

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INDUSTRY AND KENNAMETAL ...Partners in Progress

Kay W. Foote has taken a position with Cerro de Pasco Corp., Cerro de Pasco, Peru. He had been shift boss, Andes Copper Mining Co., Potrerillos, Chile.

G. A. Bustos has completed graduate work—part of the U. S. Government program for technical cooperation with foreign countries—at the University of Texas. The course which combined research and geological field work was under the direction of the USGS. Mr. Bustos has resumed an association with Texas Gulf Sulphur Co., Inc. His duties are primarily concerned with operations of Cía Exploradora del Istmo, S. A., a subsidiary of Texas Gulf Sulphur in Mexico.

Robert T. Novotny is enrolled in the graduate geophysics and geology department of the University of Utah, Salt Lake City.

R. W. Price has left Honduras and the N. Y. & Honduras Rosario Mining Co. for a job with Refinadora de Tungsteno, S. A., Sonora, Mexico.

T. V. Canning is assistant project manager, Catalytic Construction Co., Philadelphia.

George M. Darby has retired as director, Westport Mill, Dorr-Oliver Laboratories, Westport, Conn. He joined the company's Research Dept. in 1920, and has been associated with its experimental and development program. Mr. Darby will continue to serve the company as a consultant.

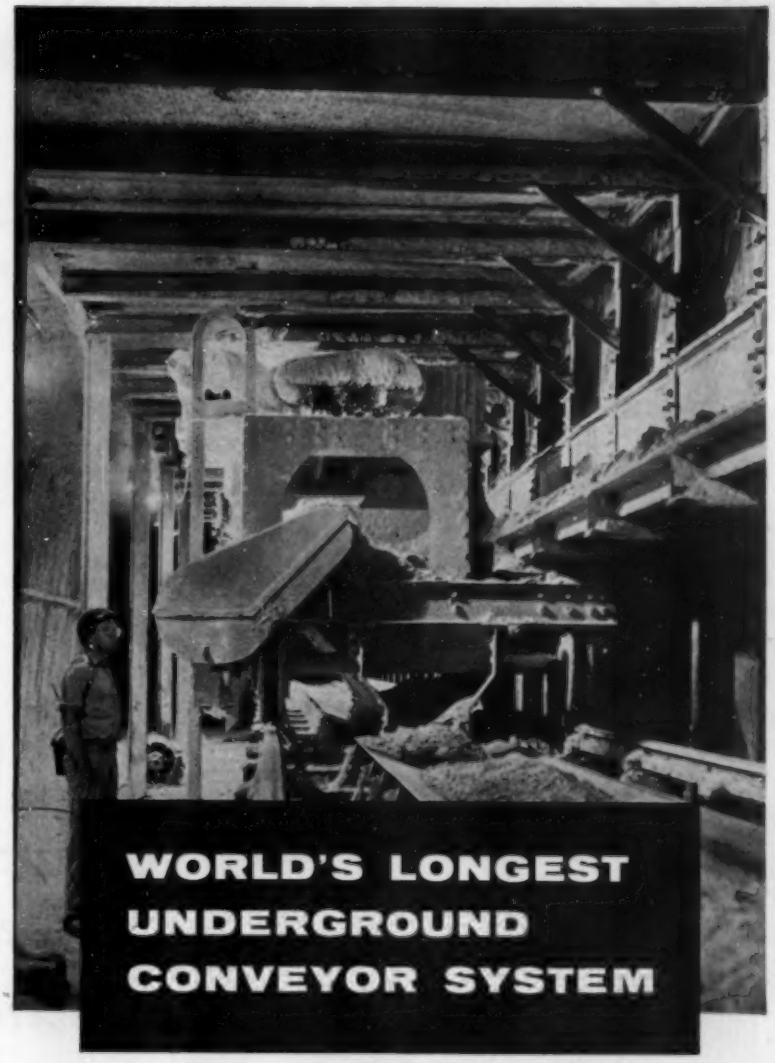
Other personnel changes include the following: **Frank L. Bosqui,** former group leader, will become business manager of the Westport Laboratories; while **Clarence J. Wall** has been named Fluo-Solids group leader.

L. H. Lange, vice president of The Galigher Co., Salt Lake City, has returned from a consulting trip to San Francisco Mines in Mexico, and visited operations in the Belgian Congo. From there, he proceeded to NChanga Copper Mines, Northern Rhodesia.

Russell M. Dugdale is with American Smelting & Refining Co., Chihuahua, Mexico.

Michael A. Kuryla has been elected a vice president and director of Cerro de Pasco Petroleum Corp. Mr. Kuryla, a graduate of Massachusetts Institute of Technology, continues as assistant manager of the Lima, Peru, division of Cerro de Pasco Corp., Del., the parent organization. At the same time **C. D. Clarke** has been named assistant to the manager of operations—mining at Cerro de Pasco Corp., with headquarters in La Oroya, Peru. **John W. Semmens,** formerly assistant superintendent, San Cristobal Mine, has been transferred to the Mahr Tunnel.

Frank J. Traversone has completed his service in the U. S. Army and is now with The Anaconda Co., Mining Dept., New York.



This rotary plow feeder is part of a 45-unit, 7½ mile Hewitt-Robins belt conveyor system located 1000 feet underground in Carlsbad, N. M. The system is designed to carry up to 550 tons of potash ore per hour from mining areas to a storage pit. Here the H-R rotary plow feeder scoops ore onto another conveyor for its trip to the refinery skip hoist.

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OBITUARIES

Elmer A. Holbrook

An Appreciation by
William R. Chedsey

I first met Holbrook about Thanksgiving time in 1908 when I was roaming among the mines of southern British Columbia. Holbrook was in charge of a mining operation at Hedley, near Princeton, B. C. He made me feel not only welcome but really at home, in spite of the fact that he was a widower and bringing up a young daughter. Our mutuality increased when we discovered that he had been in charge of a mining operation at Ruby, Mont. some years before, and I had just completed an examination of a nearby prospect for some Spokane business interests.

Holbrook was at heart an engineering educator. During my visits with him at Hedley I noticed how he gradually increased the responsibility and authority of his staff members, most of whom were rather young. He was always friendly without sacrificing his fundamental principles. That was one of his marked characteristics. On top of this he had a knack of getting people to get along with him, thus providing real leadership.

I lost contact with him for a few

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years, and next ran across him in 1920 when he was with the USBM which was sponsoring a conference in Washington, dealing with standards for mining equipment. We renewed our acquaintance and saw one another frequently. I was really happy when he joined the staff at Penn State where I had been some time, and we were indeed sorry to lose him to a neighboring institution after some five years, even though I saw him almost as frequently as I had before.

I treasure a letter which he wrote to me when I took a highly responsible new administrative position. He offered certain suggestions, but ended by saying that even though they had been helpful to him, he did not want me to consider them unless I were sure that the conditions were the same. He hoped that they would prove helpful to me. This letter was truly one of the most helpful boosts that anyone has even given me.

Not only I, but many others who knew him, some possibly even more closely than I, will feel a decided loss of a good, loyal, instructive friend. However, I feel that most of us will cherish a very happy memory of him for many years to come.

Elmer A. Holbrook

A Brief Biography by

M. D. Cooper

Elmer Allen Holbrook (Member 1908) was born in Fitchburg, Mass. in 1881, and died in Pittsburgh on Feb. 20, 1957. After graduating from Massachusetts Institute of Technology, he continued his studies at the University of Illinois, receiving the degree of Engineer of Mines. In 1949 the University of Pittsburgh conferred upon him the honorary degree of Doctor of Science. In 1905 Elmer Holbrook became superintendent, Ruby Gulch Mining Co. He became Professor of Mining, University of Illinois, in 1913, and in 1917 joined the USBM as supervising engineer and metallurgist, becoming assistant director in 1920. He served as Dean, School of Mines, at Pennsylvania State College, and the University of Pittsburgh, remaining in the latter post from 1927 until his retirement in 1950.

Active in AIME, Dean Holbrook was MIED Chairman in 1945, and was the first recipient of the MIED award in 1956. He was a director and vice president, Engineers' Society of W. Pa.; and president, Coal Mining Institute of America.

He is survived by his wife Edith and four children.

Robert Tunstall Walker

An Appreciation

by Fred Searls, Jr.

Robert Tunstall Walker, known familiarly and affectionately in geology circles as "R. T.", died in Colo-

(Continued on page 688)

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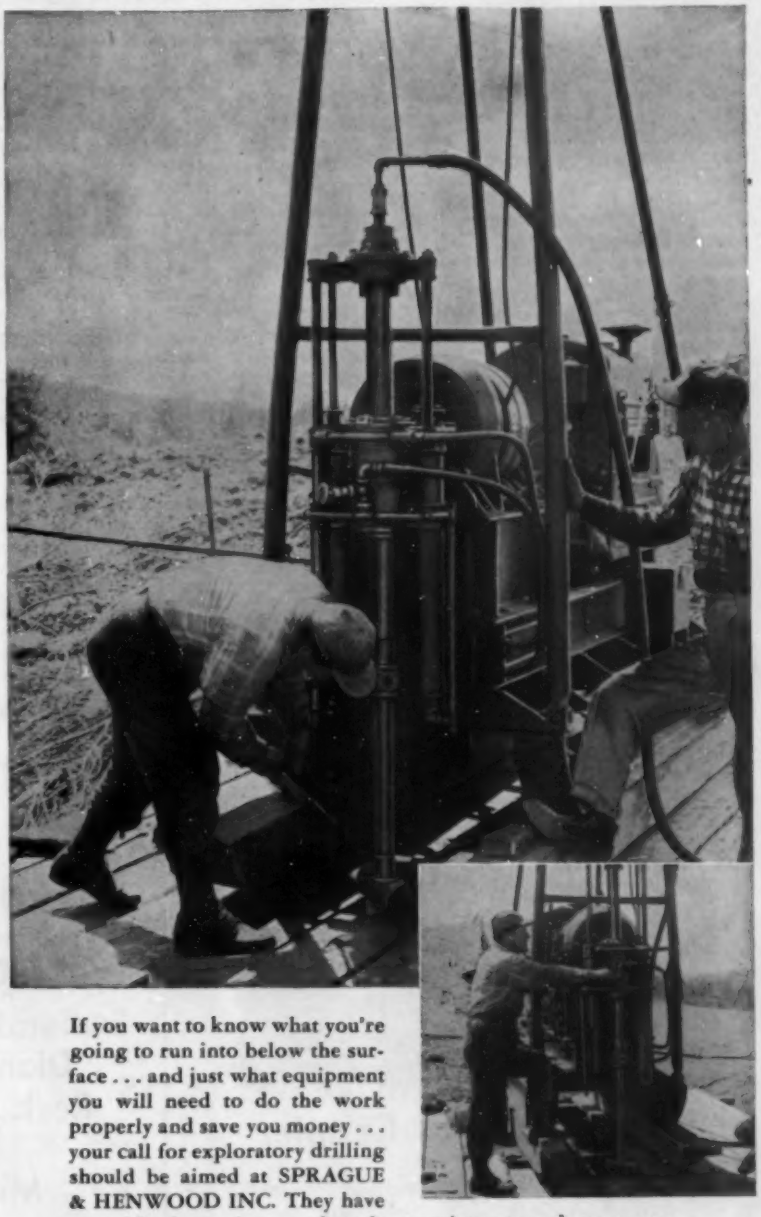

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Obituaries

(Continued from page 687)

rado Springs on Jan. 24, 1957. He was 77 years old, and nearly all of his long life was spent in Colorado and the neighboring areas of Utah, Idaho, Arizona, and Nevada.

Like several of the mining geologists active in this new branch of the science at the turn of the century, Walker spent much of his early career in directing the operation of small mines, which he had initiated. His nose for ore, developing from powers of acute observation, led to success, and to his long-time position as one of the chief geologists and counselors of the U. S. Smelting, Refining & Mining Co.'s Midvale Smelter in Salt Lake City.

For many years, he gave most of his time and technical enthusiasm to the camp of Leadville, and it is fair to attribute a large part of the production of that camp since 1938 to his geological ideas and explanations. They contributed to, and were supplemented by, "R. T.'s" energetic and unfailing optimism; and he certainly played a large part in the program of development of the northern and western parts of this great old district by the Hecla, Newmont, and U. S. Smelting, Refining & Mining companies.

"R. T.'s" contributions to geological literature were well written, often unorthodox, and always worth very thoughtful reading. Thought by himself to be his magnum opus and in a sense the climax of his long career, were the two volumes: *The Origin and History of the Earth*, published in 1954, and *The Origin and Nature of Ore Deposits*, published in 1956. These volumes, while written in text book style with many references, are more than compendiums. They reflect opinions and a philosophy of these subjects that "R. T." had achieved through years of reading, observation, cogitation and disputation with his son, W. J. Walker, and his friends. The earlier volume went to the publishers when the author was 74, and the latter when he was 76. The preface of each book consists of a tribute to the gradual accumulation, through trial and error, of solid and acceptable theories of cosmogeny, and of the origin of ore deposits. It is in this spirit that the volumes should be read and appreciated.

Who else has spent 55 years in the constant, industrious, and practical study of these subjects, and stayed his hand until his seventy-fifth year, to record the considered opinions of a long and busy life? His colleagues may differ with some of his conclusions; but they cannot fail to admire and pay tribute to his diligence, and to the ability and integrity of the scientific opinions that he and his son have set forth in these contributions to our science.

Willard T. Rogers (Member 1940) died of a heart attack on July 10, 1956, at the age of 55. A native of Fillmore, Utah, he attended the University of Utah and graduated from Utah State Agricultural College in 1928. Mr. Rogers began his career with Los Angeles & Salt Lake Railroad Co. where he worked as a draftsman, later joining the Utah Copper Co., in the same capacity.

Necrology

Date Elected	Name	Date of Death
1943	Allan E. Craig	April 7, 1957
1920	J. S. Hazen	Feb. 13, 1957
1955	Frank G. McCutcheon	Mar. 27, 1957
1940	Dimitry Niconoff	Mar. 16, 1957
1952	Howard R. Youngkrantz	Mar. 27, 1957

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The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's office if names of people are found who are known to be unqualified for AIME membership.

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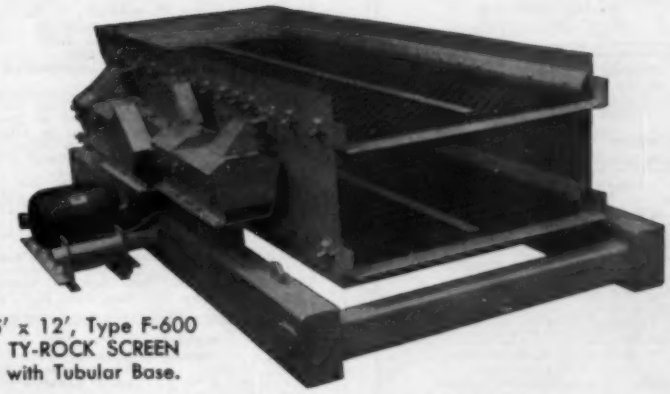

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Coming Events

June 16-21, ASTM, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 29, AIME Adirondack Section, visit by AIME President Grover J. Holt and trip to St. Lawrence Power Project and Seaway.

July 27, AIME Adirondack Section, plant trip to Canadian Johns-Manville Co. Ltd., Asbestos, Que., and dance at Sherbrooke, Que., Canada.

Aug. 19-23, Sixth National Clay Conference, University of California, Berkeley, Calif.

Sept. 5-7, New Mexico Geological Soc., 8th annual field conference, Durango-Silverton-Ouray area, southwestern Colorado.

Sept. 8-Oct. 9, Commonwealth Mining and Metallurgical Congress, British Columbia to Nova Scotia, Canada.

Sept. 9-12, American Mining Congress, annual convention, Utah and Newhouse Hotels, Salt Lake City.

Sept. 13, AIME St. Louis Section, joint meeting with Amer. Chemical Soc. St. Louis Section. Hotel York, St. Louis.

Sept. 18-21, International Mineral Dressing Congress, Royal Inst. of Technology, Stockholm, Sweden.

Sept. 19, AIME Utah Section, *The Story of Mining and Milling at the Calera Mining Co., Cobalt, Idaho,"* by E. B. Douglas, manager of the company, Newhouse Hotel, Salt Lake City.

Oct. 3-5, Seventh Annual Exploration Drilling Symposium, University of Minnesota, Center for Continuation Study, Minneapolis.

Oct. 6-9, AIME Society of Petroleum Engineers, fall meeting, Adolphus, Baker, and Statler-Hilton Hotels, Dallas.

Oct. 9-11, ASME-AIME Coal Div., Joint Solid Fuels Conference, Chateau Frontenac, Quebec.

Oct. 15-18, AIME, Society of Mining Engineers Annual Meeting and Southeastern States Mining Conference, Hillsboro and Tampa Terrace Hotels, Tampa, Fla.

Oct. 30-Nov. 1, AIME Rocky Mountain Minerals Conference, Denver.

Nov. 11-14, Society of Exploration Geophysicists, 27th annual meeting, Statler-Hilton Hotel, Dallas.

Feb. 16-20, 1958, AIME Annual Meeting, Hotel Statler, New York.

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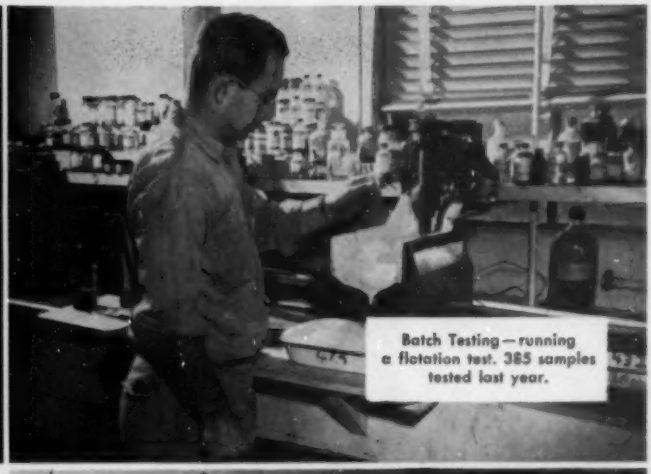

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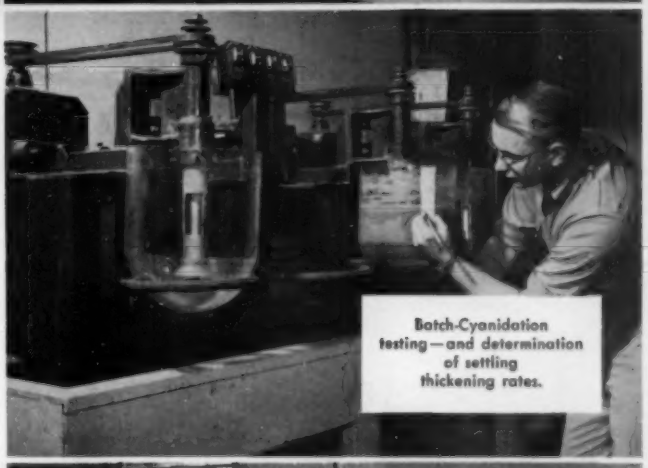

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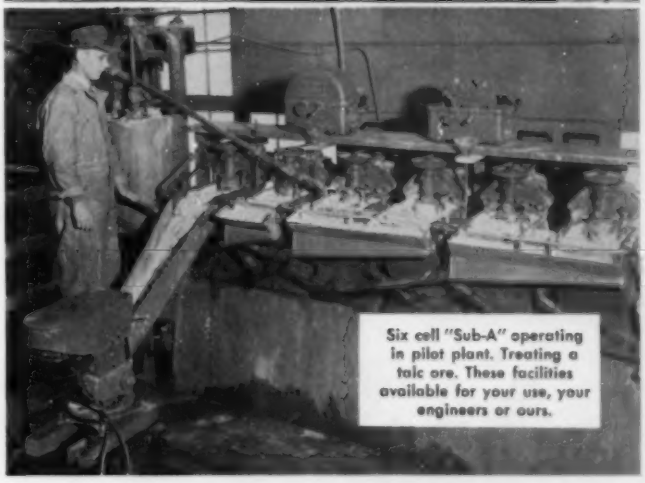

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